Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

CEH Wallingford
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB

The 2007 East Stoke Salmon Counter Records

W R C Beaumont
L Scott
A T Ibbotson

Project Leader:	W R C Beaumont (wrb@ceh.ac.uk)
Report to:	Public Domain
CEH Project No:	C02896NEW / C02038NEW
Date:	March 2008

INTELLECTUAL PROPERTY RIGHTS

CONFIDENTIALITY STATEMENT

'In accordance with our normal practice, this report is for the use only of the party to whom it is addressed, and no responsibility is accepted to any third party for the whole or any part of its contents. Neither the whole nor any part of this may be included in any published document, circular or statement, nor published in any way without our written approval of the form and context in which it may appear.'

CONTENTS

1. ABSTRACT

Data on the numbers and sizes of salmon ascending the CEH East Stoke Salmon Counter in 2007 are presented and a brief summary of the run and hydrological characteristics for the year given.

2. INTRODUCTION

The data in this report represents the 35th consecutive year of the East Stoke counter's operation recording the upstream movement of Atlantic salmon (*Salmo salar* L.) in the River Frome. As such it represents the most comprehensive record of salmon movement in England and Wales. Data from the adult salmon counter, together with the data on smolt migration now being obtained, will allow a stock/recruitment model to be produced for the Frome salmon. This will allow identification of the critical mortality phases of the salmon to be ascertained, allow a better estimate of spawning targets required and enable an intelligent management of the stock.

Data are collected by a Scottish Hydro-Electric (formerly North of Scotland Hydro-electric Board (NSHEB)) Mk Xb resistivity counter. The counter is connected to three stainless steel electrodes mounted 450 mm apart on the Environment Agency venturi gauging weir at East Stoke (NGR SY 867868). Data are verified by a combination of trace waveform analysis (see Beaumont *et al*. 1986), video frame-grab and videotape analysis. A more full description of the history of the counter and preliminary long-term results are given in Beaumont *et al.* (2006).

In conjunction with data on salmon movement, information on water temperature, air temperature and light levels (including a measure of the brightness of the night) are also collected at 15 minute intervals. Hydrological (discharge) summaries are derived from Environment Agency data (Copyright © Environment Agency). All data are collated into hourly records.

Salmon run data are presented for the period February to January inclusive. Past data and personal observations indicate that the majority of the upstream movement in January is caused by the continued migration of fish from the previous calendar year migrating to spawn, not fish migrating to spawn in 11 months time.

Numbers used in this report refer to both “gross” and “nett” numbers of fish ascending the counter. Gross number refers to the total number of fish moving up over the weir irrespective of whether they subsequently drop back down over the weir. Nett numbers are the gross upstream number minus the number of downstream counts. The reason for the two figures is that between 1974 and 1984 only coincident downstream counts (counts immediately preceding or following an upstream count) were subtracted from the upstream totals. These were considered to be salmon vacillating over the counter and were subtracted from the upstream counts (reducing the total by about 12%). Other downstream counts were not recorded. With the development of the computer verification system (Beaumont *et al* 1986) it was discovered that about 40% of all downstream counts were caused by salmon; thus leading to an overestimate of about 10% in nett upstream counts. Thus, since 1985 the coincident downstream counts have not been routinely subtracted from the counter totals and all downstream counts have been recorded. These data are now individually verified (by waveform analysis and video) and the figure for nett upstream movement determined. This more accurate measure of nett upstream number averages out at ~80% of the gross number and is positively correlated with the gross number (r^2=95%). However, in order for better comparability with data prior to 1985, gross data are still presented. These data, whilst not being as precise as nett numbers, will still show accurately the trend of salmon numbers and will be within approximately 12% of the pre-1985 data.

3. ASSOCIATED AND FUTURE WORK

For the past five-years we have been tagging juvenile salmon in the Frome catchment with PIT tags. These small tags (just 12 mm long x 2 mm wide) enable us to individually identify the fish using a reader. The data collected in this study will enable us to link the growth rates of the juvenile fish with the time spent at sea before returning and the marine growth rate. Data on freshwater survival, marine survival and life history strategy, from different tributaries will also be obtainable. The tags record the passage of the PIT tagged fish out to sea by equipment mounted on the East Stoke smolt counter and the main river weir (Figure 1). The main river reader also allows the detection of the return of the PIT tagged adult fish. In September for each of the past three years we have tagged approximately 10,000 juvenile salmon (probably about 10-20% of the autumn population). The fish we tagged in 2005 migrated to sea as smolts in 2006 (and were detected on the smolt counter) and this year we saw the return of several PIT tagged 1-sea-winter grilse.

We are also continuing to monitor the “autumn” downstream run of parr in the river and working with Cefas in looking at the state of adaptation to salt water of these fish and where they migrate to. We know some of these fish reside in the lower river downstream of Wareham and we currently have some of these fish tagged in order to follow their movement patterns. We will also be examining returns from the adult fish to see if the survival of these early moving fish is better or worse than the fish that migrate in the spring, the “usual” migration time for the smolts.

Figure 1 The main river adult counter and RAPID PIT tag detection system

We are not rearing and releasing any salmon in the Tadnoll Brook & River Cerne this year but have been monitoring the 35,000+ fry we have put in over the past two years. Both these two Frome tributaries did not have a natural run of fish due to obstacles in the lower reaches. On the Tadnoll a fish pass has now been constructed and on the Cerne our research is supporting the business case for the fish pass on the weir at Louds Mill (Dorchester) that is due to be built next year. The fish introductions should kick-start the recolonisation of these two streams and in mid-January this year we found evidence for this in the form of a spent female salmon on a redd in the Tadnoll.

The large-scale gravel cleaning programme that we in conjunction with the Environment Agency began in 2003 has been continued. Poor survival of the eggs in the spawning gravel has been shown to be a key bottleneck in the recruitment of fish into chalk streams. Data from a joint CEH/Cefas study (Scott and Beaumont 1993) has shown that survival can be increased from 10% to 66% by cleaning the spawning areas. We hope to continue this programme in future years and will be providing training for, and liaising with, fishing groups carrying out the cleaning as well as monitoring the effects on subsequent smolt and salmon production. For the third year running we have just completed a survey of the distribution of the redds in the river and will be assessing these locations with regard to the cleaned areas.

Under an agreement with the river Frome salmon net licence holder and the Environment Agency the CEH Fish-Group is also monitoring the salmon net catch from Poole Harbour. All fish caught are being released and we will be tagging and tracking some to help understand their movement patterns and survival in the lower river. This new area of research for us opens up exciting possibilities of understanding the behaviour of adult fish in the lower river and the influence of temperature and discharge on their passage through the lower river.

4. 2007 DATA REPORT

A large part of the effort in running the East Stoke counter is focussed on verifying the "counts" from the counter. Counts are verified by either video picture (when the water is clear) or the shape of the electrical waveform produced when an object goes across the weir or (more often) both. Video data is combined with electrical waveform data so both can be recorded on videotape. In addition, frame grabs can be taken from the computer screen and stored, thus to some extent making it unnecessary to view the video data (apart from assessing missed fish). Only rarely is raw, unverified data used. An example of the computer verification system's display is shown in Figure 2. A salmon can be seen on the video picture and the electrical trace is shown on the bottom segment of the screen. Text boxes along the bottom of the display record, number of records; number of frame grabs; input signal value; time of day; number of records registered by computer and counter.

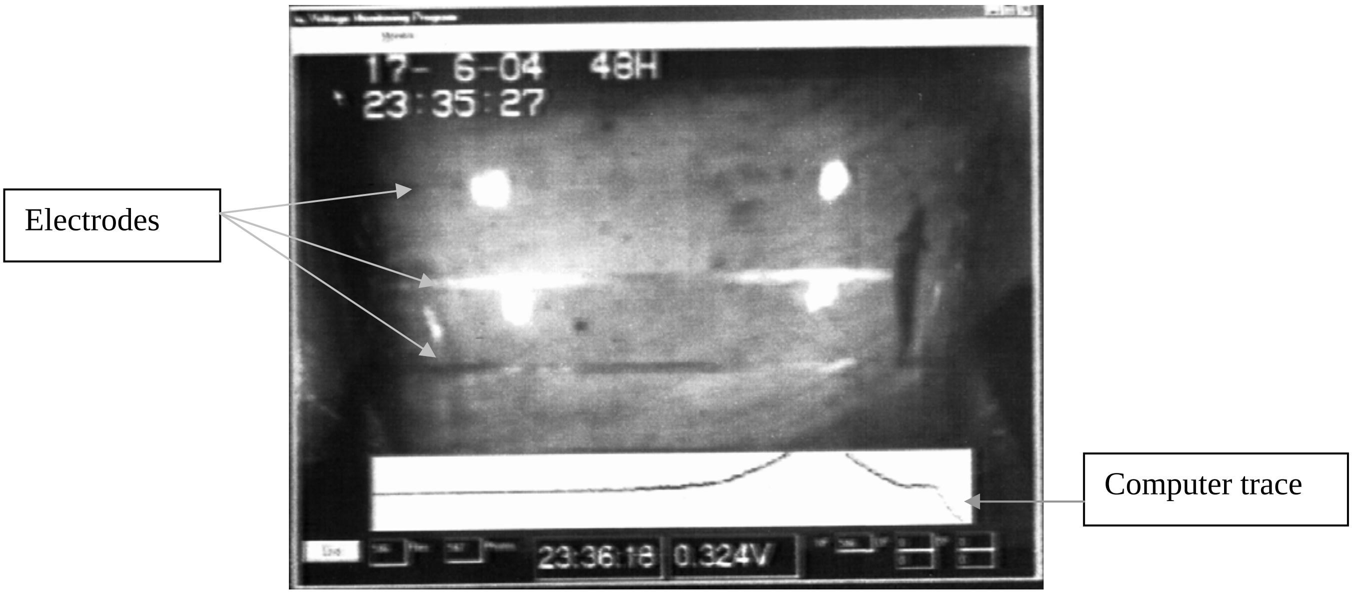


Figure 2 Screen display from the computerised counting and evaluation system. The image shows a 75 cm salmon ascending the weir

As well as verifying the counts the video also shows some intriguing pictures and Figure 3 shows (left picture) a pike with a large trout in its mouth going down the counter and (right picture) two salmon and a pike (right-hand fish) ascending the weir together.

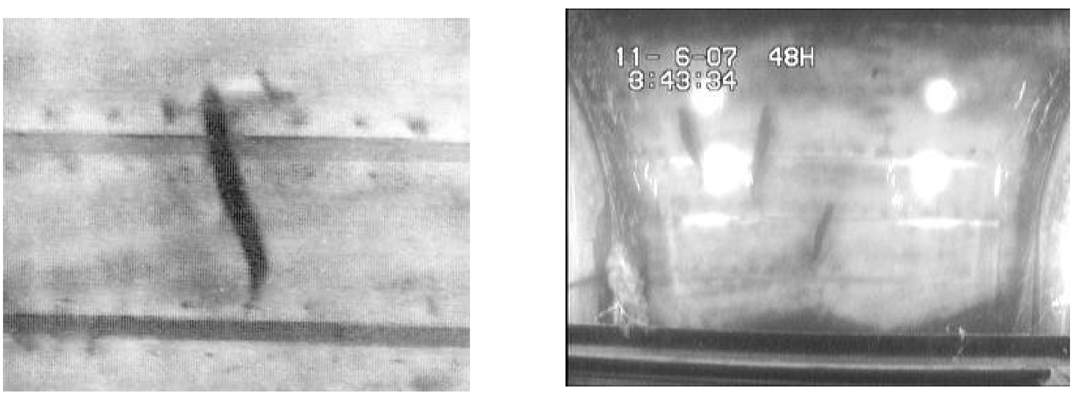


Figure 3 Computer frame grabs from the computerised counting and evaluation system

Unfortunately in the spring we had a major problem with the adult salmon counting system. It seems that some large debris came through the weir, (rumour has it that it was a "Portaloo!), and broke one of the underwater wires leading to the counting electrodes. One of the main river PIT tag detecting vanes was also broken off and another seriously damaged. With the high water level we were unable to affect a permanent repair of the electrode wire until June. Various temporary repairs were of limited success but did give us data for some periods. Fortunately the water clarity was generally very good during the period when the counter was out of action and we have been able to assess salmon numbers by watching the video tapes from the weir. Although this is a long and tedious process the data is very high quality. For the period 14th May to 6th June however the water was high and dirty and (apart from one two-day period) no video data was obtainable, thus there is no counter data for that period. In November and December we again had some mechanical damage to the RAPID detection system and this also necessitated another period when the counter was not operational and there was no monitoring of PIT tag numbers. Over the year the electronic counter was not operating for 69 days, also for 69 (often different) days there was no video or waveform verification. A total of 28 days had no count information from either electronic or video source. Figure 4 summarises the operational times and verification diary for the counter in 2007.

For part of the year we also trialled a new version of the fish counter. This Mk 11 version produced by EA Technology Ltd is a very advanced design and incorporates into the unit waveform collection and storage, video frame grab and logging of environmental data. The unit we tested was designed for operation in low conductivity upland rivers and so was not as efficient as our old Mk10b unit at detecting fish. Video viewing however ensured that fish records were still accurate.

Verification of the data entailed verifying the upstream and downstream counter records plus many thousand (due to the number of false counts recorded) computer waveform traces. For periods when the computer system was not operational accuracy of the counter was assessed by direct examination of the video data. When the computer system was operational accuracy of assessment was carried out by comparing identity assessed from computer traces with identity observed from video records (both tape and video frame grabs). Data from the actual counter could vary widely in accuracy and on a day to day basis could equal 0% if it missed fish. Raw data from the counter is rarely used in an unverified form however and the data for the run is compiled from a combination of counter, computer and video records i.e. all computer trace records and counter records are checked on the video to identify the cause of the record. Raw fish counter data is only used when computer or video data are not available. Provided adequate water clarity, video records are 100% accurate and assessment of accuracy of interpretation of the computer records is made from comparing trace identity with the video records. Where water clarity is poor just computer records are used to verify data. In 2007 a total of 238 days had usable video data and for 128 days video verification was not available (due to turbid water etc). Accuracy of the computer records is usually checked by viewing complete time periods on video (approximately one 24-hour period every month) and comparing the numbers from the computer with the numbers of fish seen. Data are not however corrected for verification error. Because of the testing of he Mk 11 counter and the other problems associated with running the counter this year however little such verification has been carried out (or is in confidence to the Mk 11 manufacturers).

Figure 5 shows daily counts together with mean daily discharge data. Data from the counter are presented for both gross upstream and gross downstream counts as well as the nett upstream count. In January to March the counter detects the post-spawning fish (kelts) moving downstream. In order to prevent an undercount of the fish moving upstream during this period the downstream counts are not subtracted from the upstream counts for these months. Whilst nett numbers equate to the estimated numbers of salmon ascending the river, gross numbers are included to allow comparison with data obtained prior to 1985 when total downstream numbers were not recorded and verified.

Gross total for the year was 901
Nett total for the year was 655

Figure 6 shows that the total nett upstream count for the year was about the level of the 5-year average of the very low runs that have been recorded since 1999. Gross run data is the second highest since 1999 and thus slightly above the 1999-2006 average.

Figure 7 shows the nett numbers of fish migrating over the weir for each month, the graph also shows the average numbers for 1985-1990 (representing the start of the recording of nett numbers and before the 1991 crash in numbers) the years 1991 to 1998 (when the first sustained drop in numbers occurred) 1999 to 2006 (the second period of very low numbers) and the current year (2007). The figure shows that, until August the run was below that of the average for the 1999-2006 years. In August however numbers running increased to above the average until November when they again dropped to finish just (14 fish) below the 99-06 average.

Figure 8 shows time of day of fish movement over the weir. The avoidance of daylight hours during the summer months can be clearly seen.

A total of 366 upstream migrating fish (56% of the nett run) were measured this year (Figure 9) with the largest fish being 92 cm although a very large salmonid fish (in excess of 1 m long) was seen but no accurate measurement could be made due to turbid water conditions. Data from fish below 50 cm and fish that are obviously the same fish vacillating over the weir have been excluded from figure 9 (and the data set).

Figure 10 shows data from the hourly database for each month. As well as gross upstream salmon numbers in an hour, hourly averages (4 x 15 minute readings) of water discharge (East Stoke Millstream (ESMS) discharge is shown separately as dark blue on top of light blue main river (East Stoke flume) discharge – upper boundary of data therefore is total discharge) from Environment Agency data. Air temperature, water temperature and light level are also shown. Data from the low light meter are missing this year due to equipment failure. This high sensitivity light meter data is designed to show bright nights to see if night-time illumination level affects the run pattern. The equipment will be repaired as soon as possible. Graphs of the hourly data clearly show the clarity of detail available with the hourly time-base.

Figure 11 shows mean monthly discharge data (in cubic metres per second (cumecs)) for 2007 together with mean (1966-2006) 5, 25, 75 and 95 percentile discharge data. This data is collated and calculated from Environment Agency records. The river discharge started the year high (above the Q3 level) and remained high until March. July to September also had high discharge and was above the 95%ile level for July and August. Despite one of the worst "spates" seen on the Frome in November (see Figure 8 for hourly discharge data for that month) values were within the inter-quartile range for October and November. Figure 12 shows the mean annual discharge data for the Frome (together with the 5-year and long-term average for 1966 to 2006) and shows a significant increase over the past 2-years values.

5. REFERENCES

Beaumont W R C, Mills C A and Williams G (1986) The use of a microcomputer as an aid to identifying objects passing through a resistivity fish counter. *Aquaculture & Fisheries Management* **17**, 213-226.

Beaumont**,** W.R.C., Pinder, A.C., Scott L. & Ibbotson A.T. (2007) A history of the river Frome salmon monitoring facility and new insights into the ecology of Atlantic salmon. *Proceedings of the Institute of Fisheries Management 37th Annual Study Course. Minehead* pp179-194

Scott A and Beaumont W R C (1994) Improving the survival rates of Atlantic salmon (*Salmo salar* L.) embryos in a chalk stream. *Institute of Fisheries Management Annual Study Course, 1993, Cardiff.*

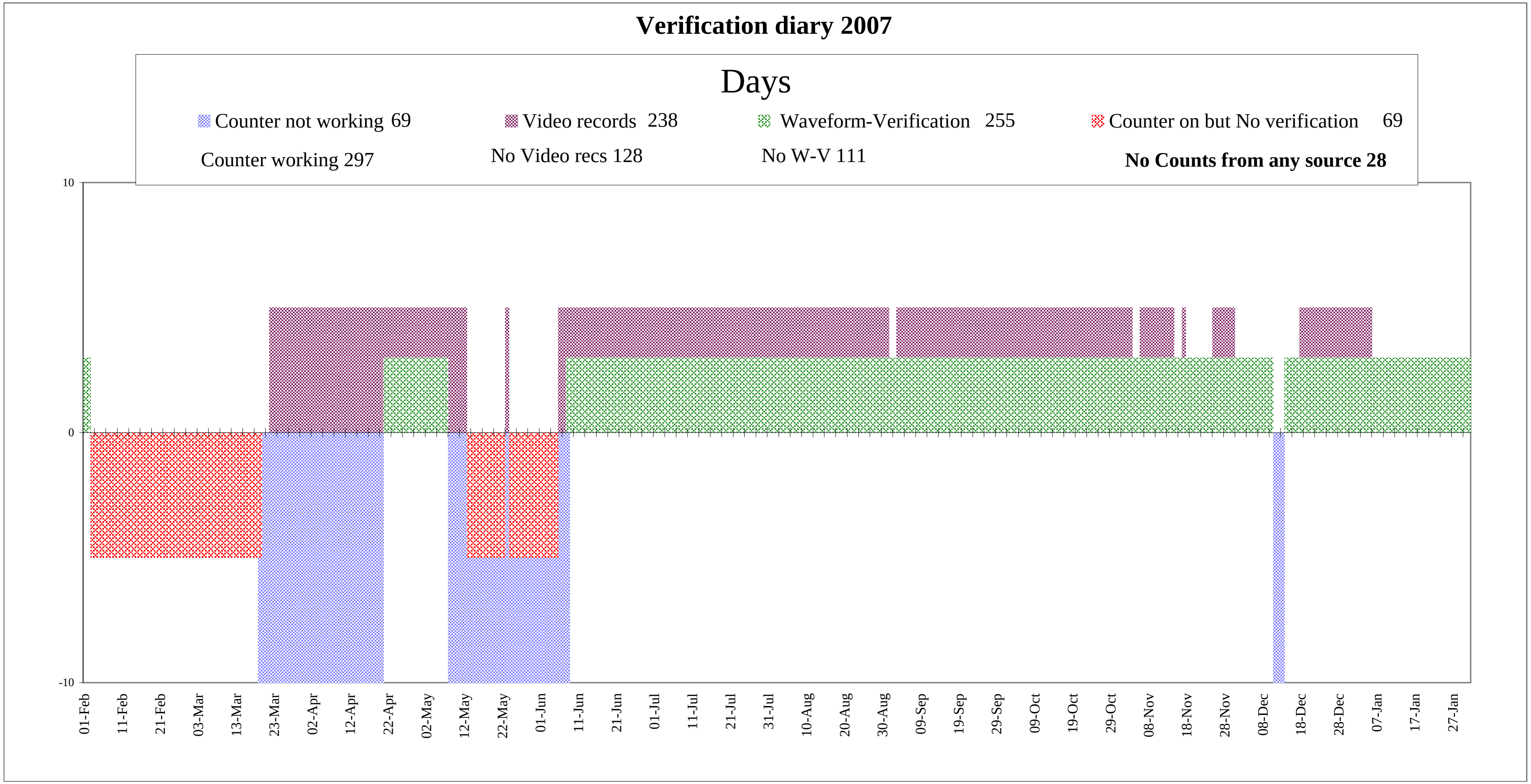


Figure 4 Operational times and verification diary 2007

	MONTH												
Month	***Feb-07***	***Mar-07***	***Apr-07***	***May-07***	***Jun-07***	***Jul-07***	***Aug-07***	***Sep-07***	***Oct-07***	***Nov-07***	***Dec-07***	***Jan-08***	**Total**
Gross U/S	**3**	**3**	**8**	**15**	**80**	**109**	**127**	**26**	**230**	**219**	**63**	**18**	**901**
Gross D/S	**3**	**3**	**1**	**5**	**13**	**22**	**18**	**5**	**50**	**93**	**39**	**16**	**268**
Nett U/S	**3**	**3**	**7**	**10**	**67**	**87**	**109**	**21**	**180**	**126**	**24**	**18**	**655**

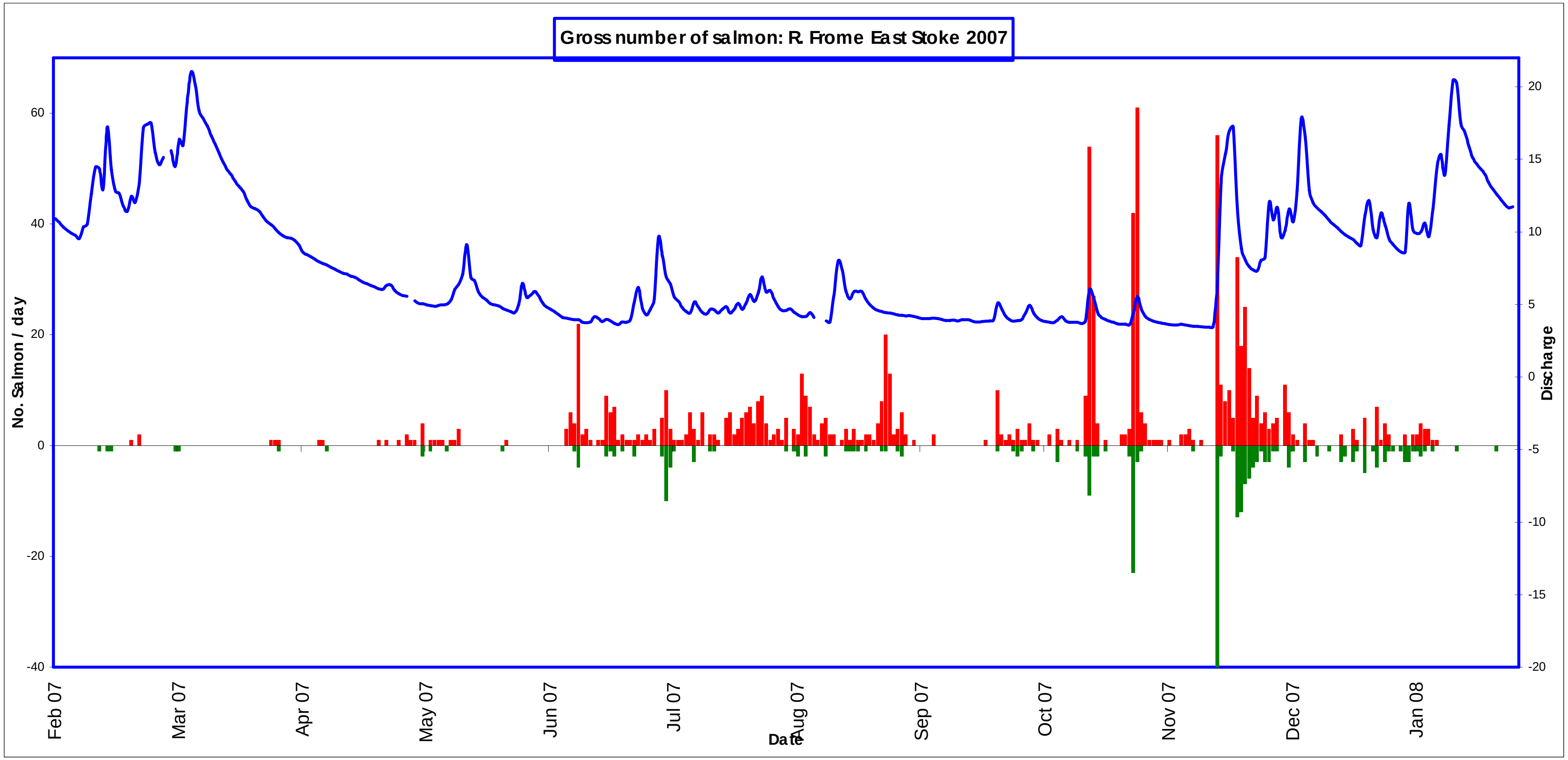
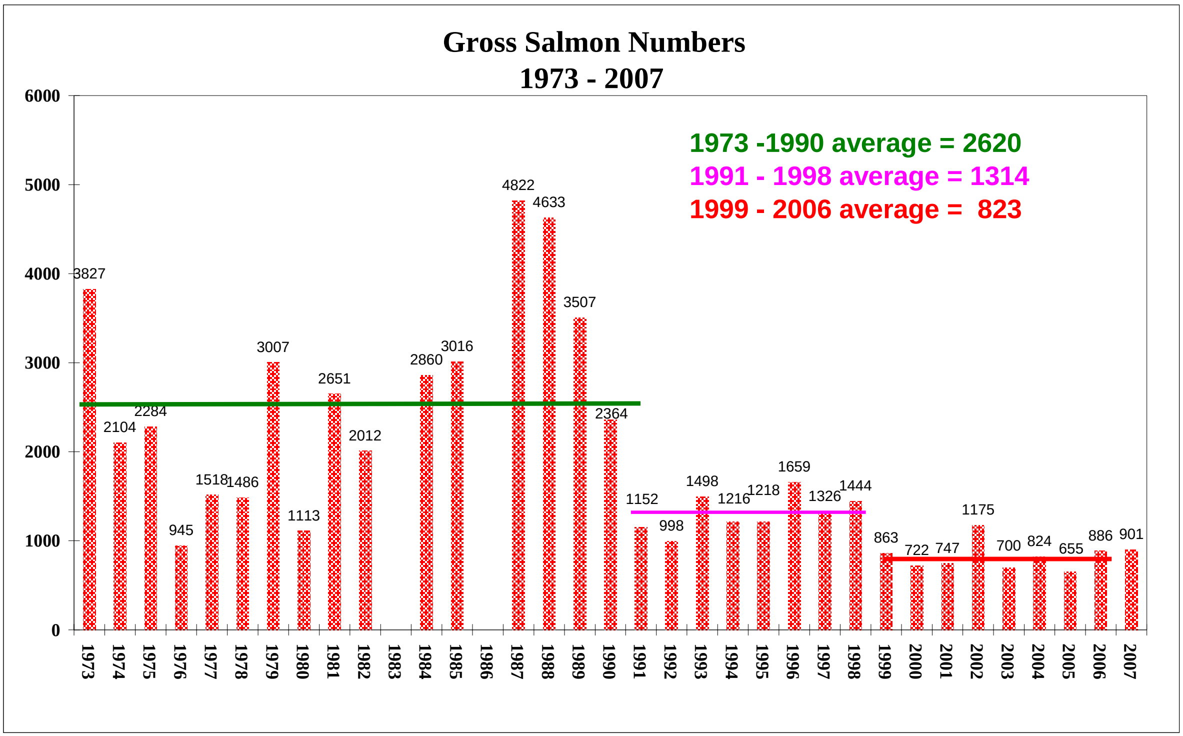


Figure 5 Centre for Ecology and Hydrology: East Stoke Salmon Counter Data 2007



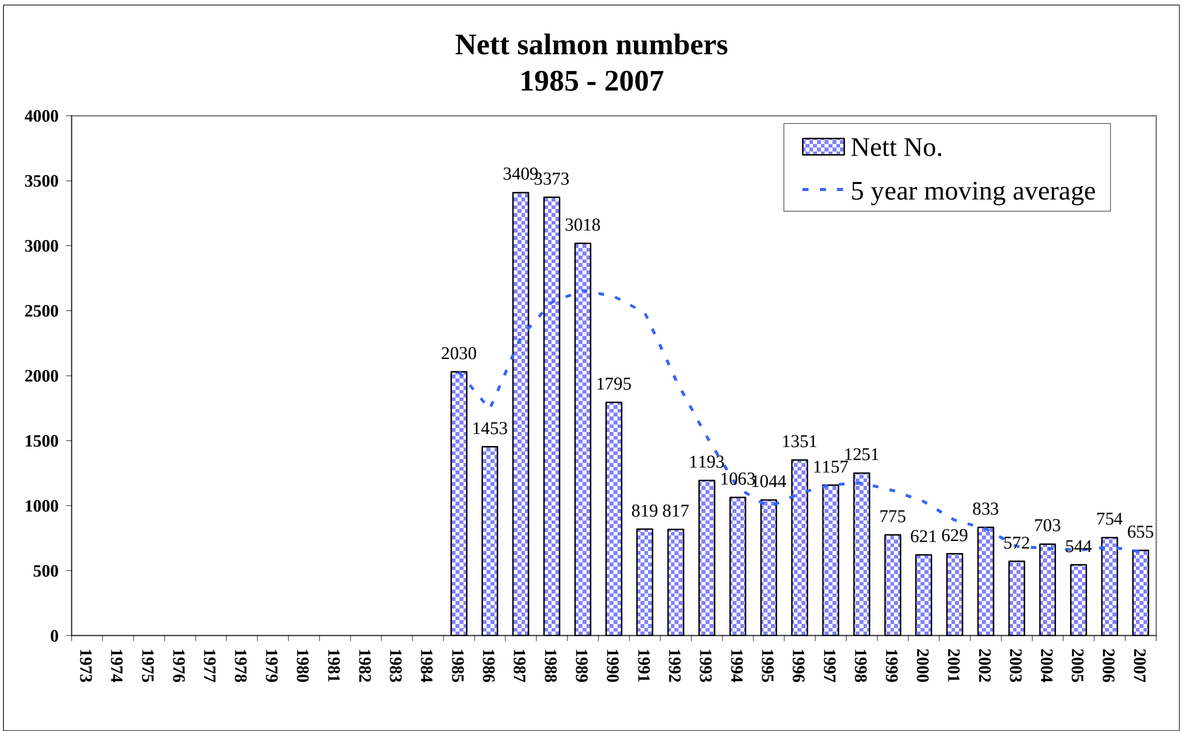


Figure 6: Gross and Nett numbers of salmon ascending the East Stoke weir

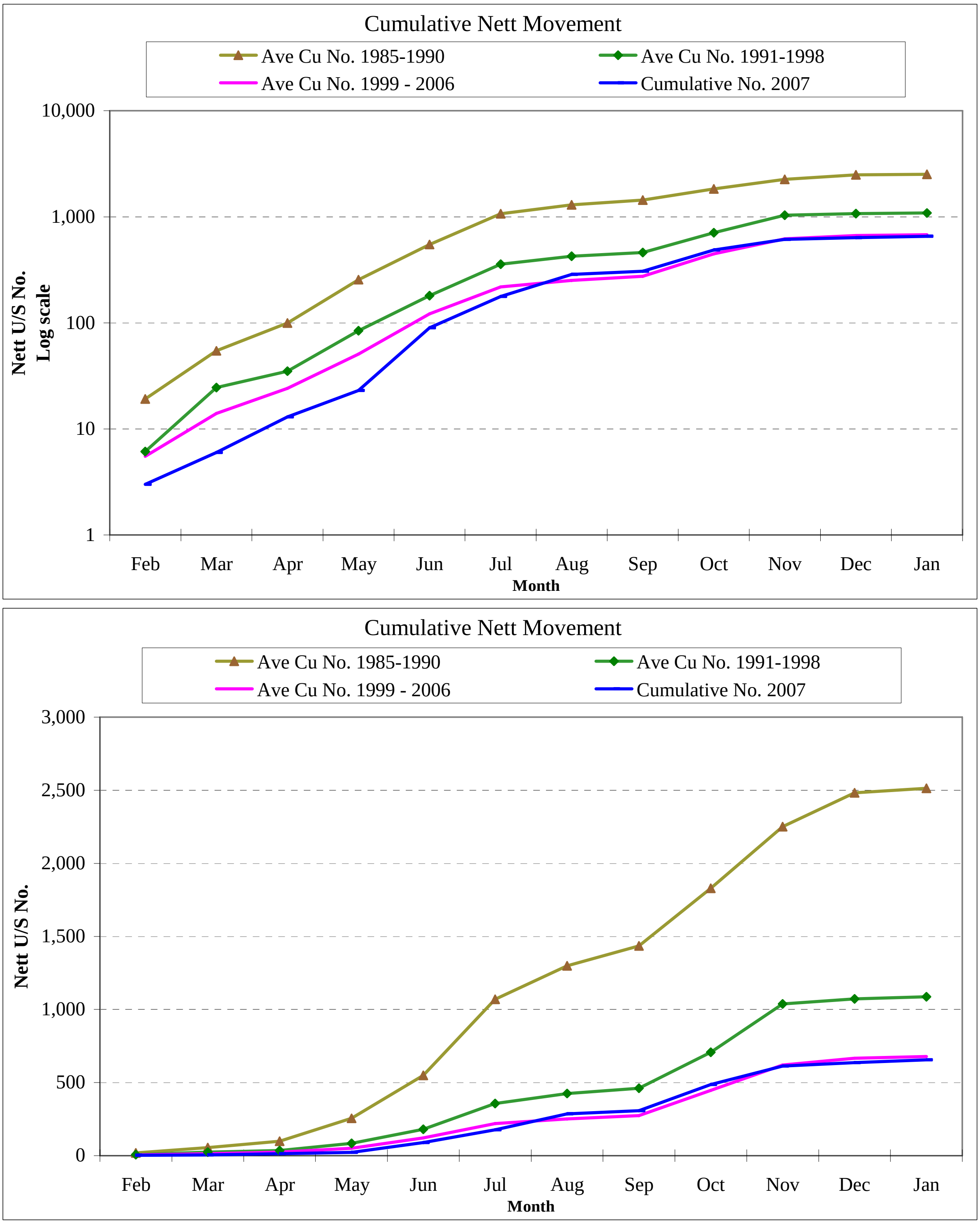


Figure 7: Comparison of Nett 2007 data with previous years. Note: On top graph y-axis (Nett No.) is on a logarithmic scale to better show the early months when low numbers of fish are present.

Figure 8: Time of day of movement (Gross upstream and downstream count data)

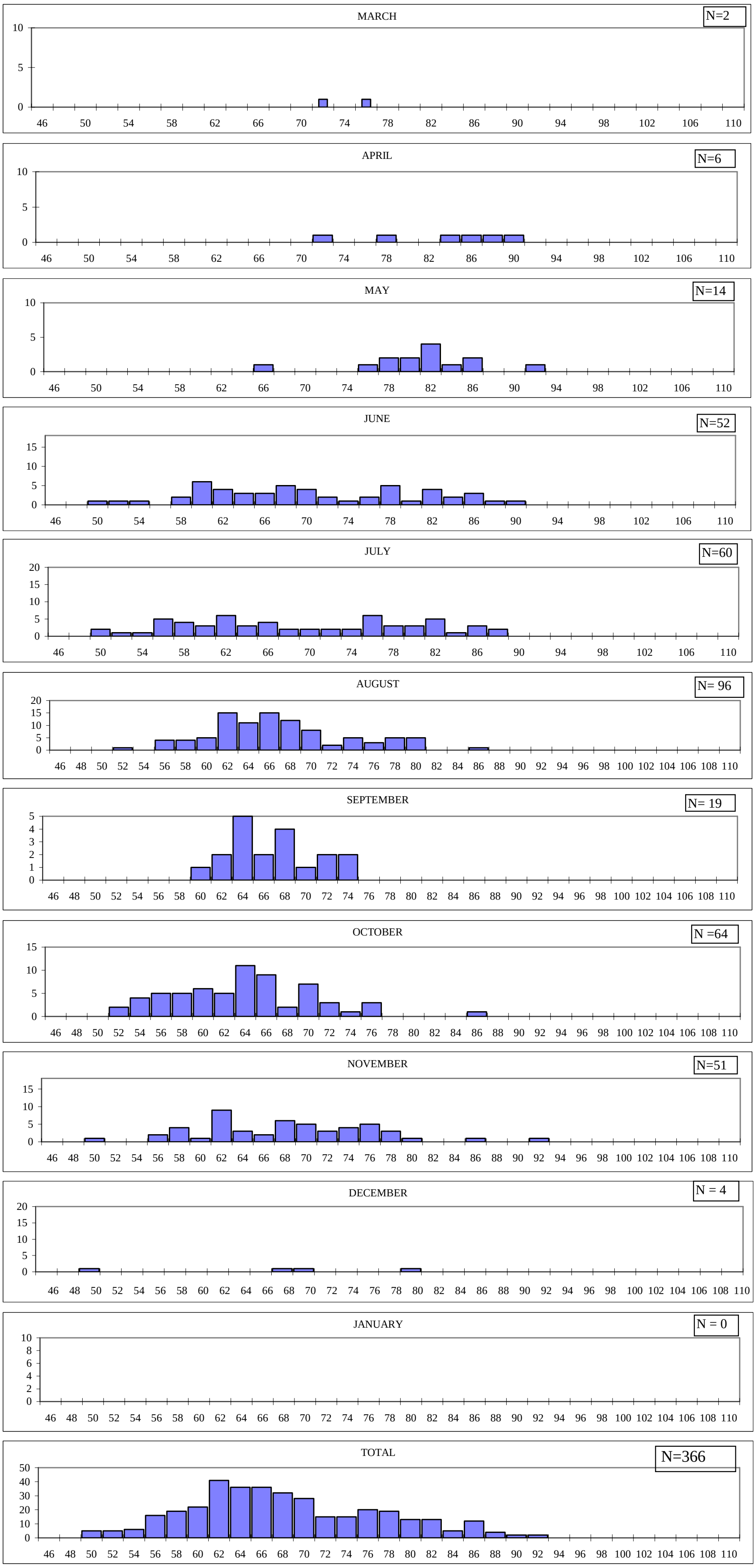
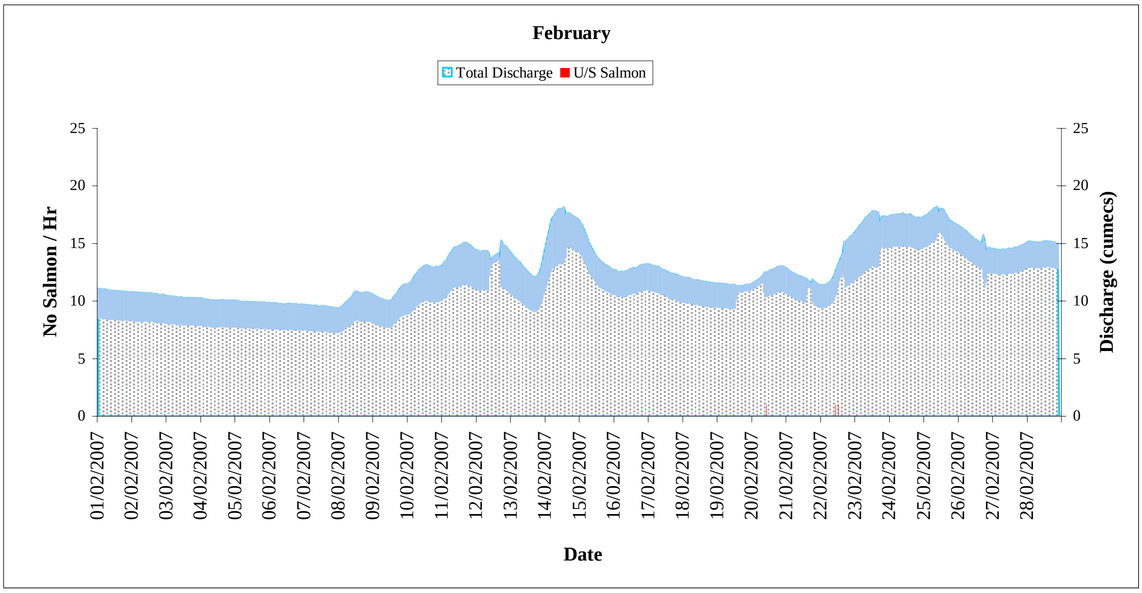
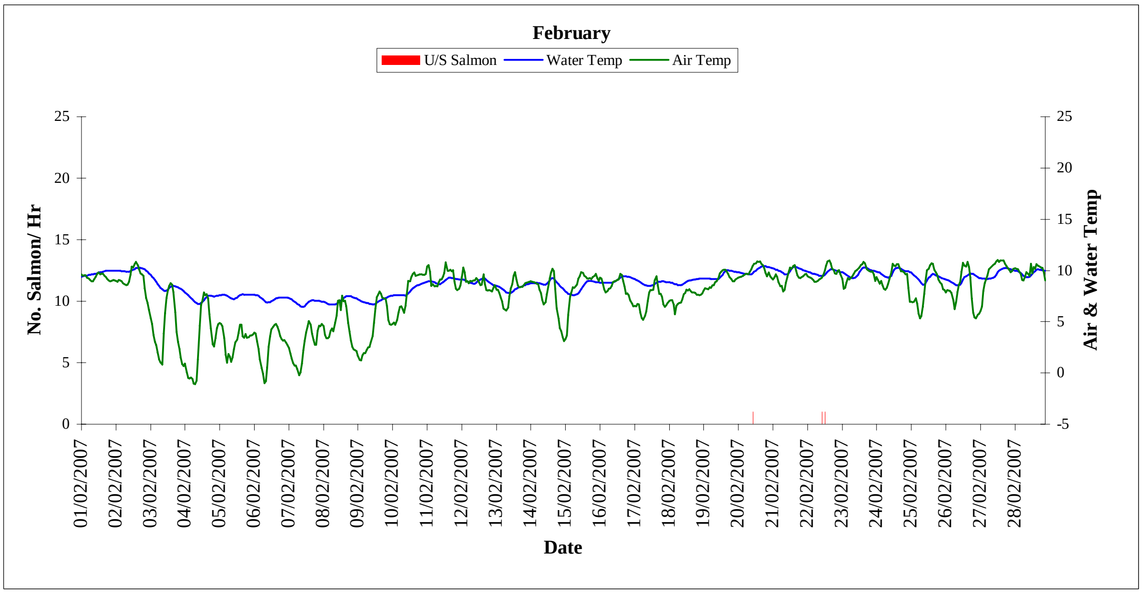


Figure 9: Length of upstream migrating fish each month (Length in cm)





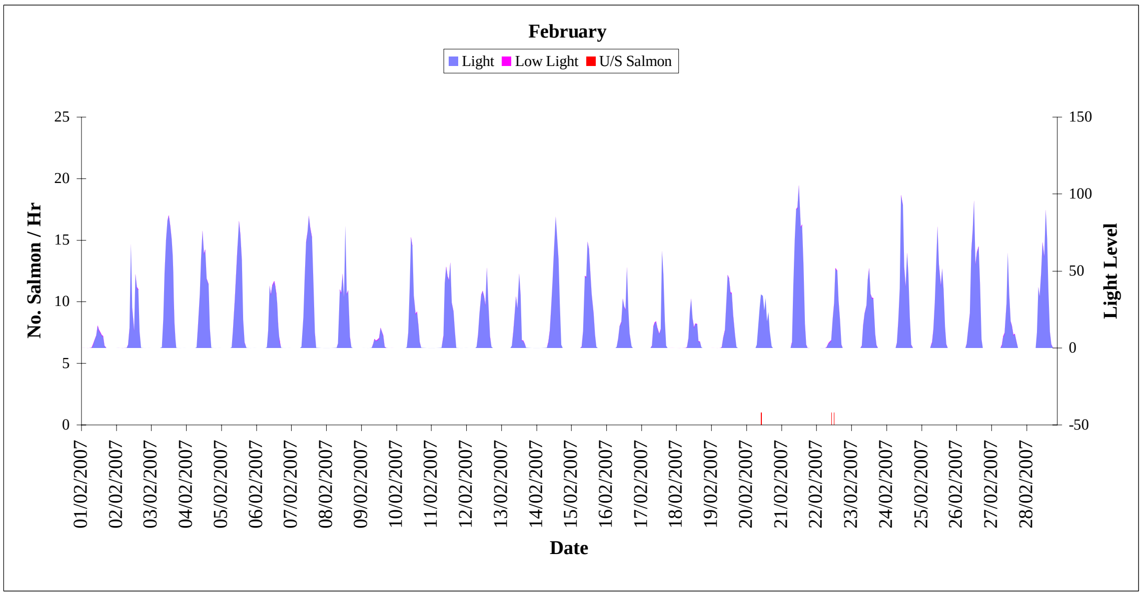
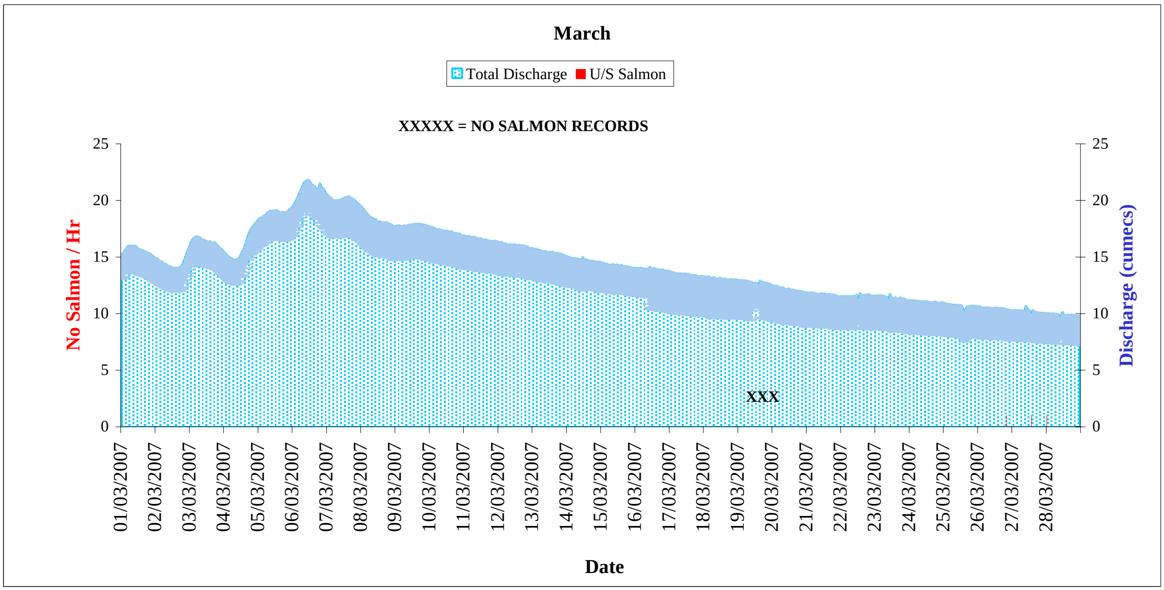
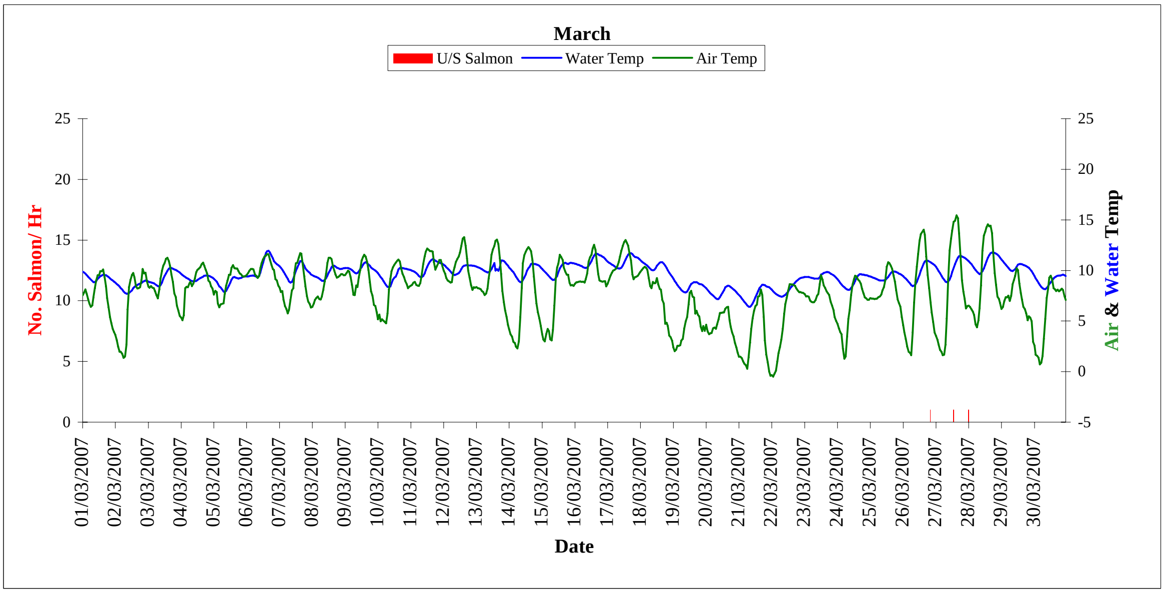


Figure 10: Hourly data





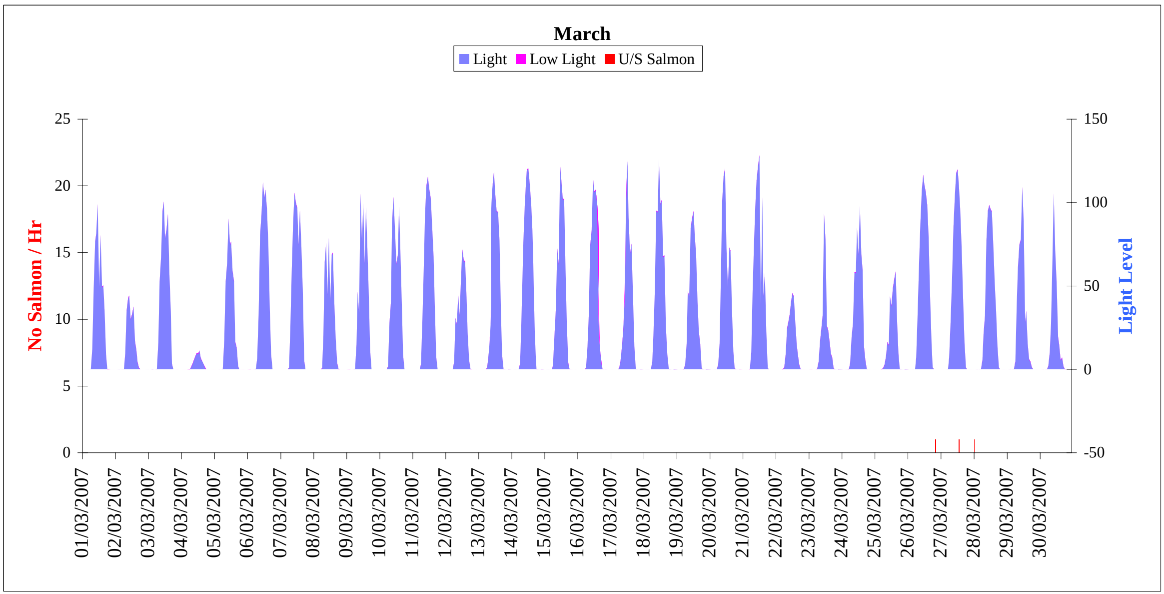
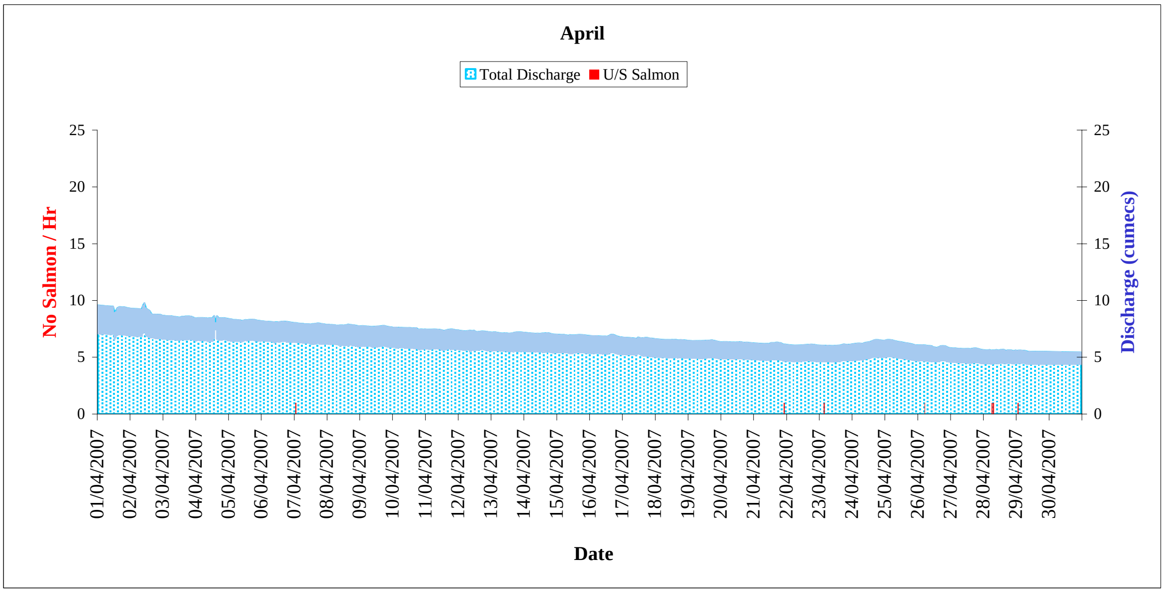
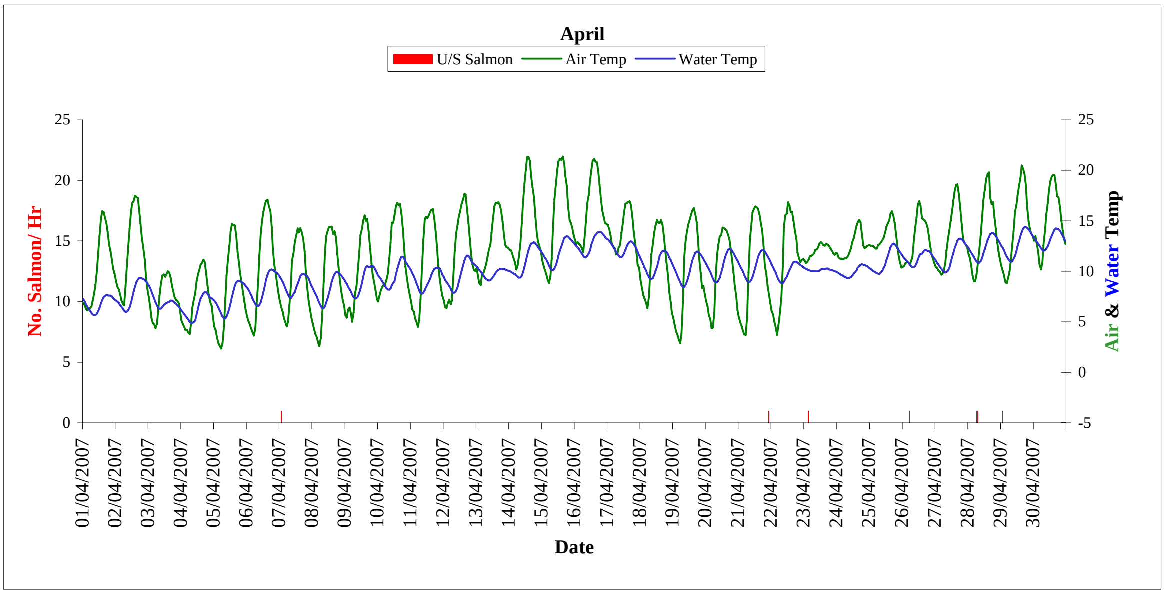


Figure 10: Hourly data





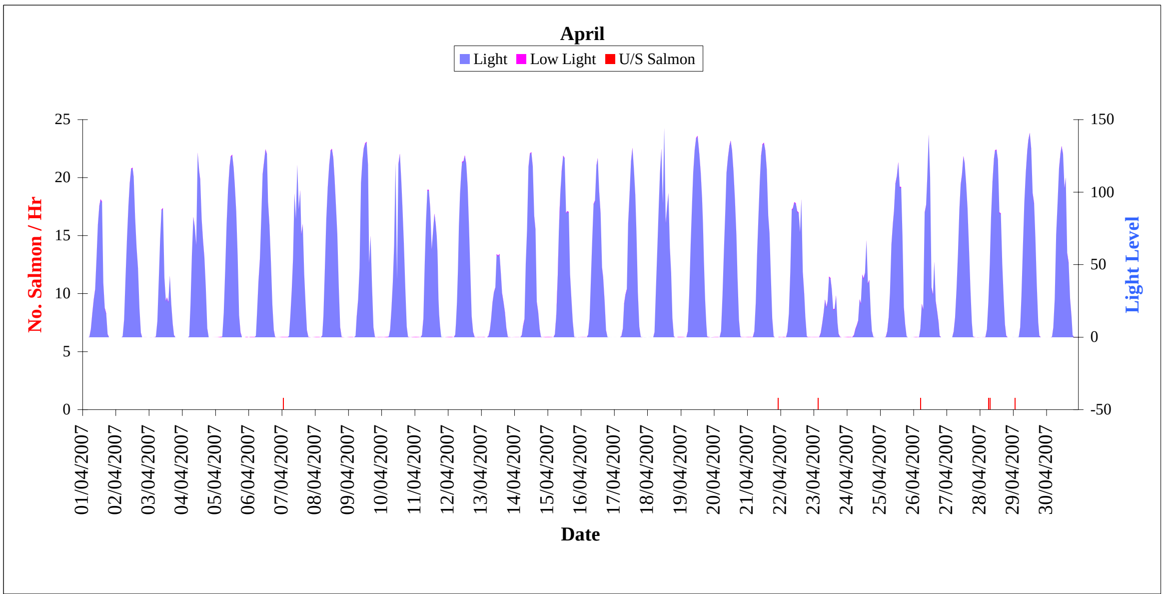
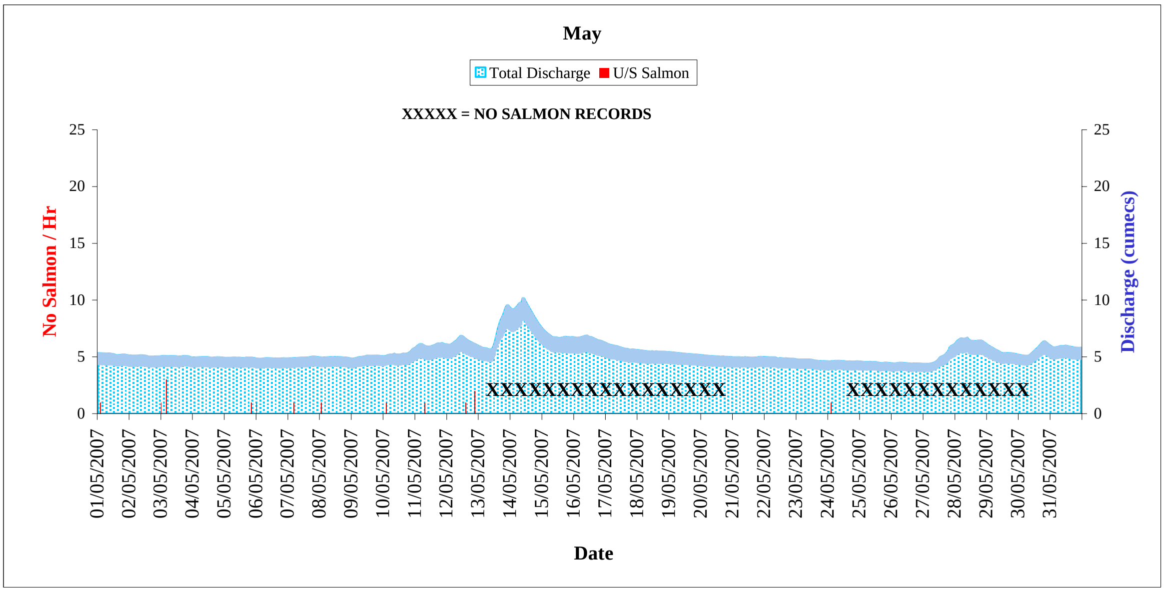
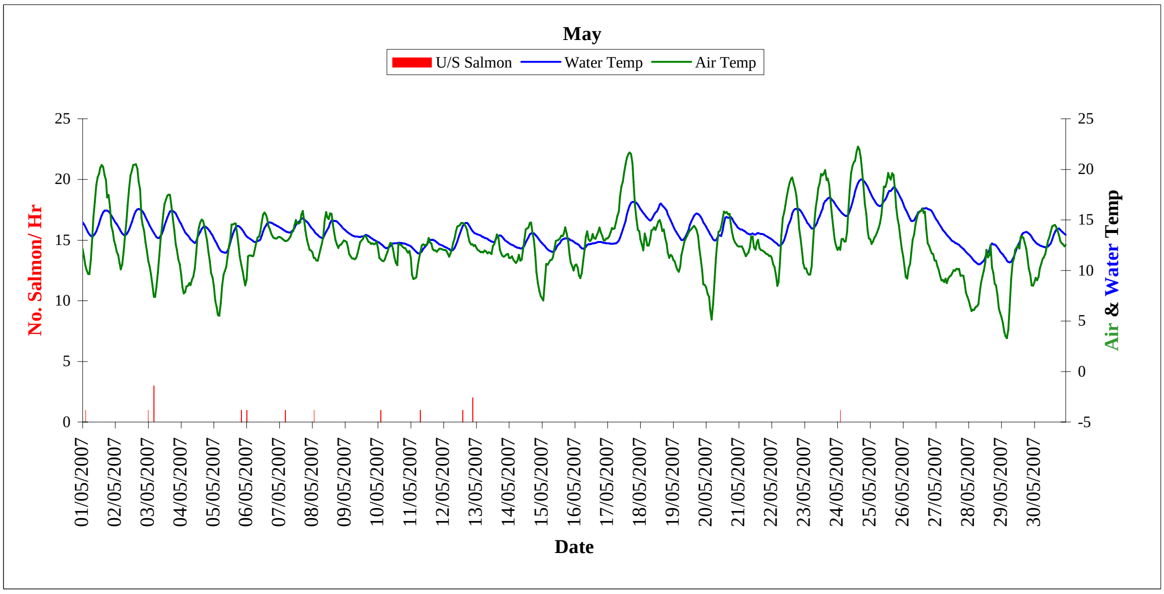


Figure 10: Hourly data





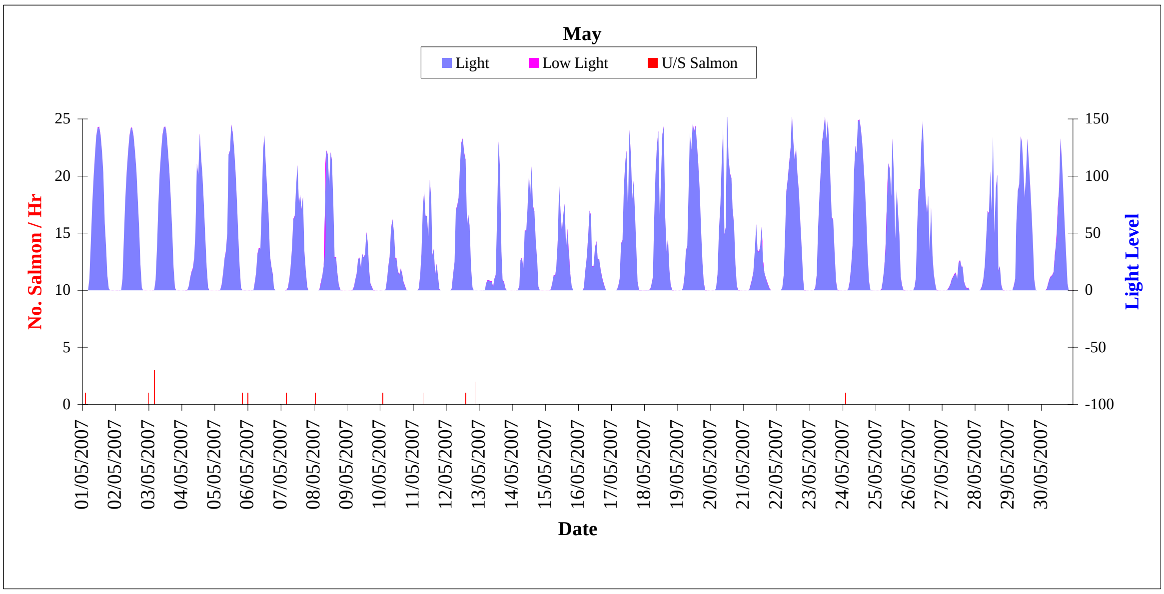


Figure 10: Hourly data

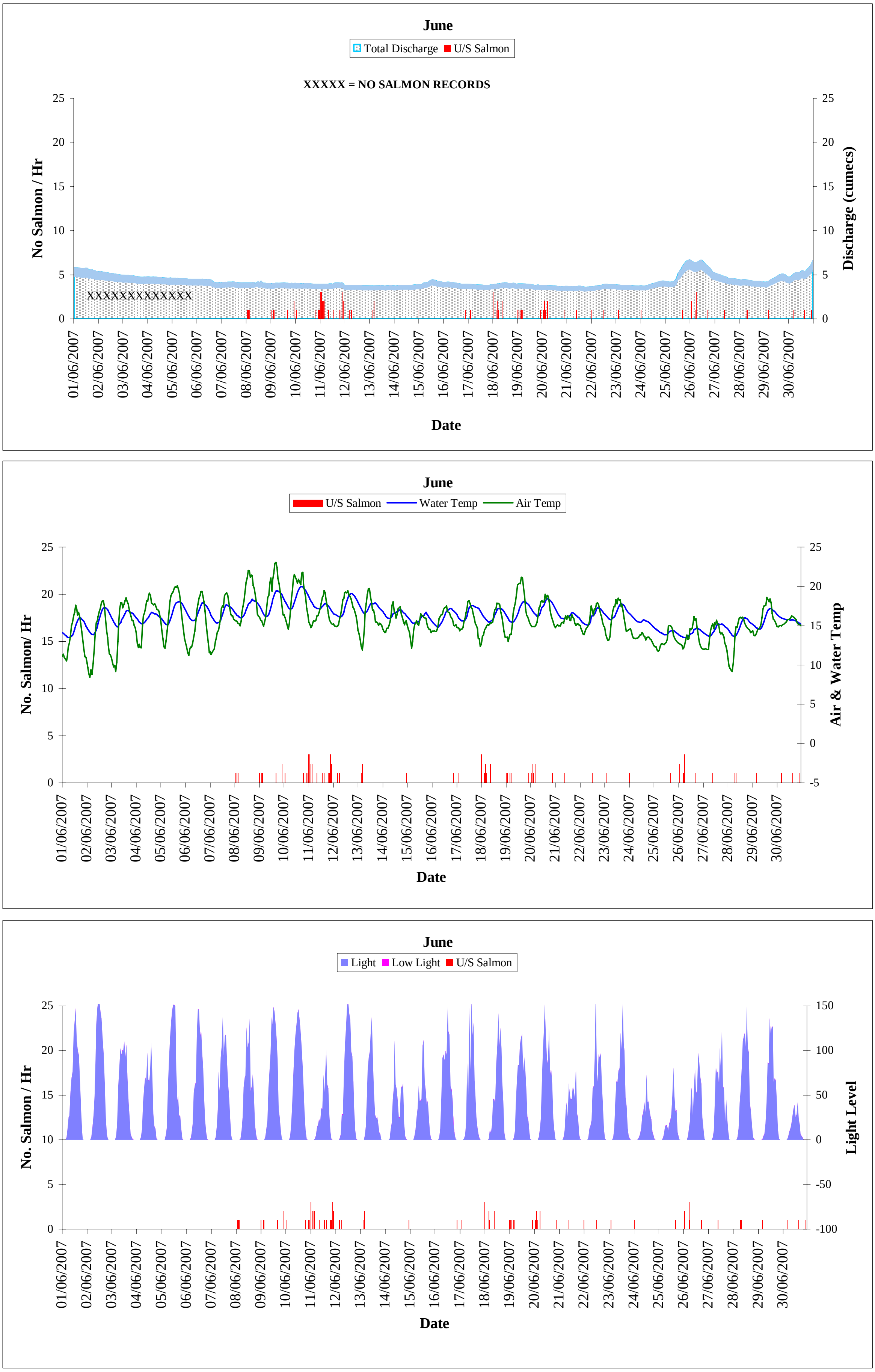
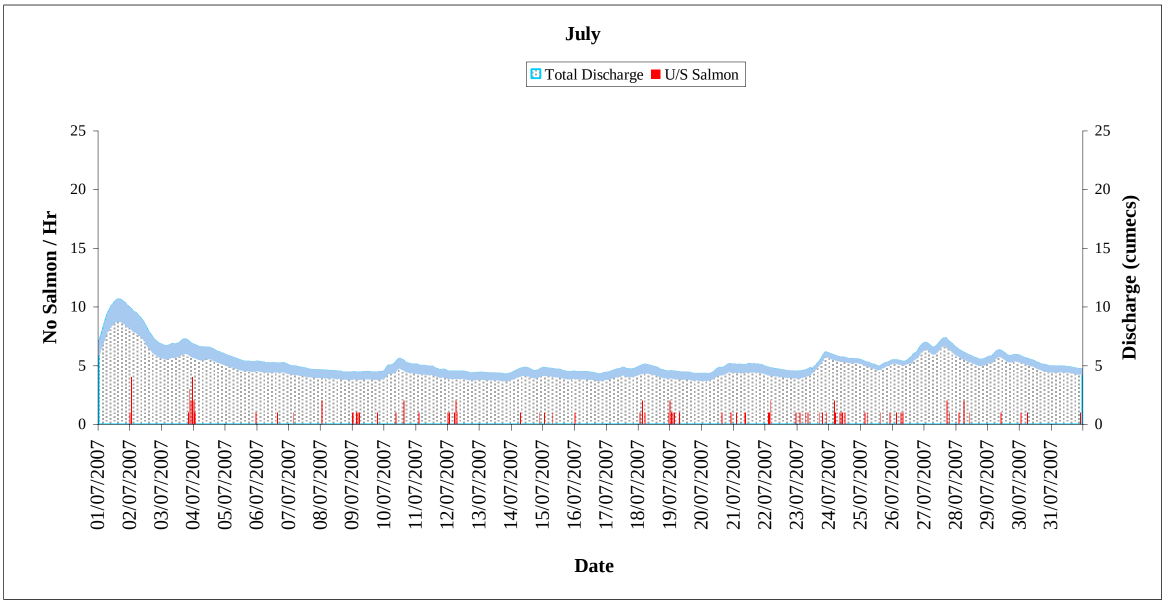
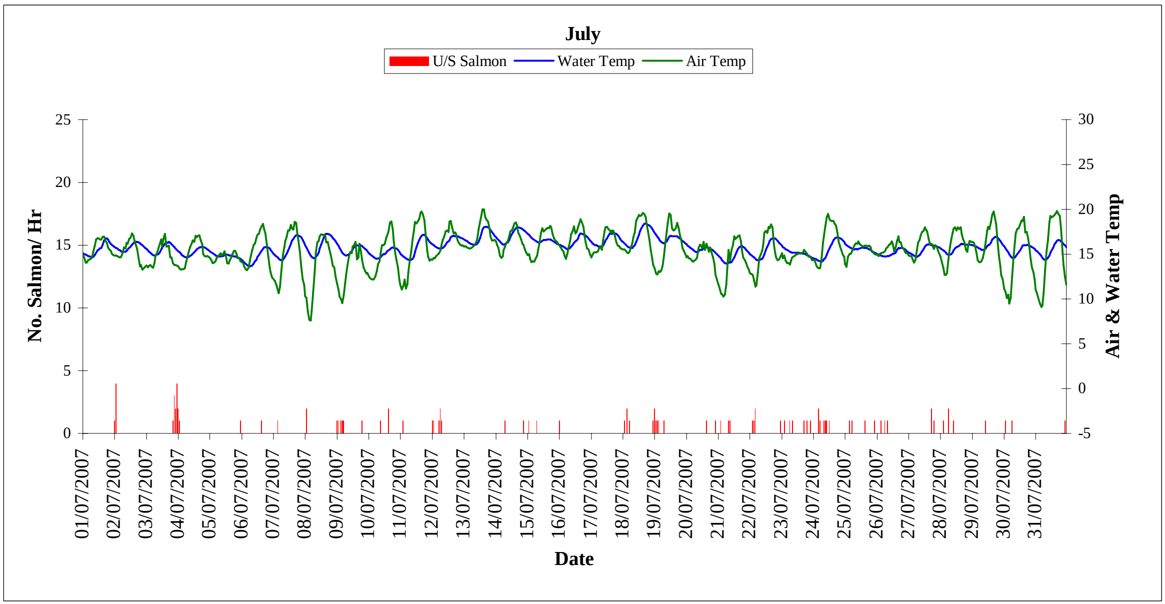


Figure 10: Hourly data





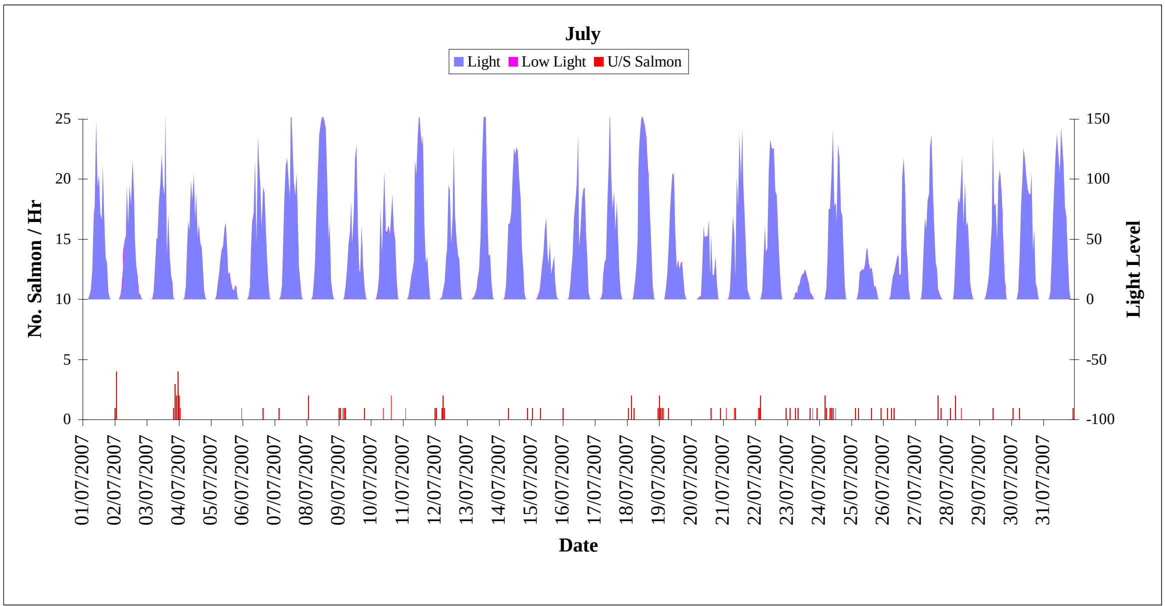


Figure 10: Hourly data

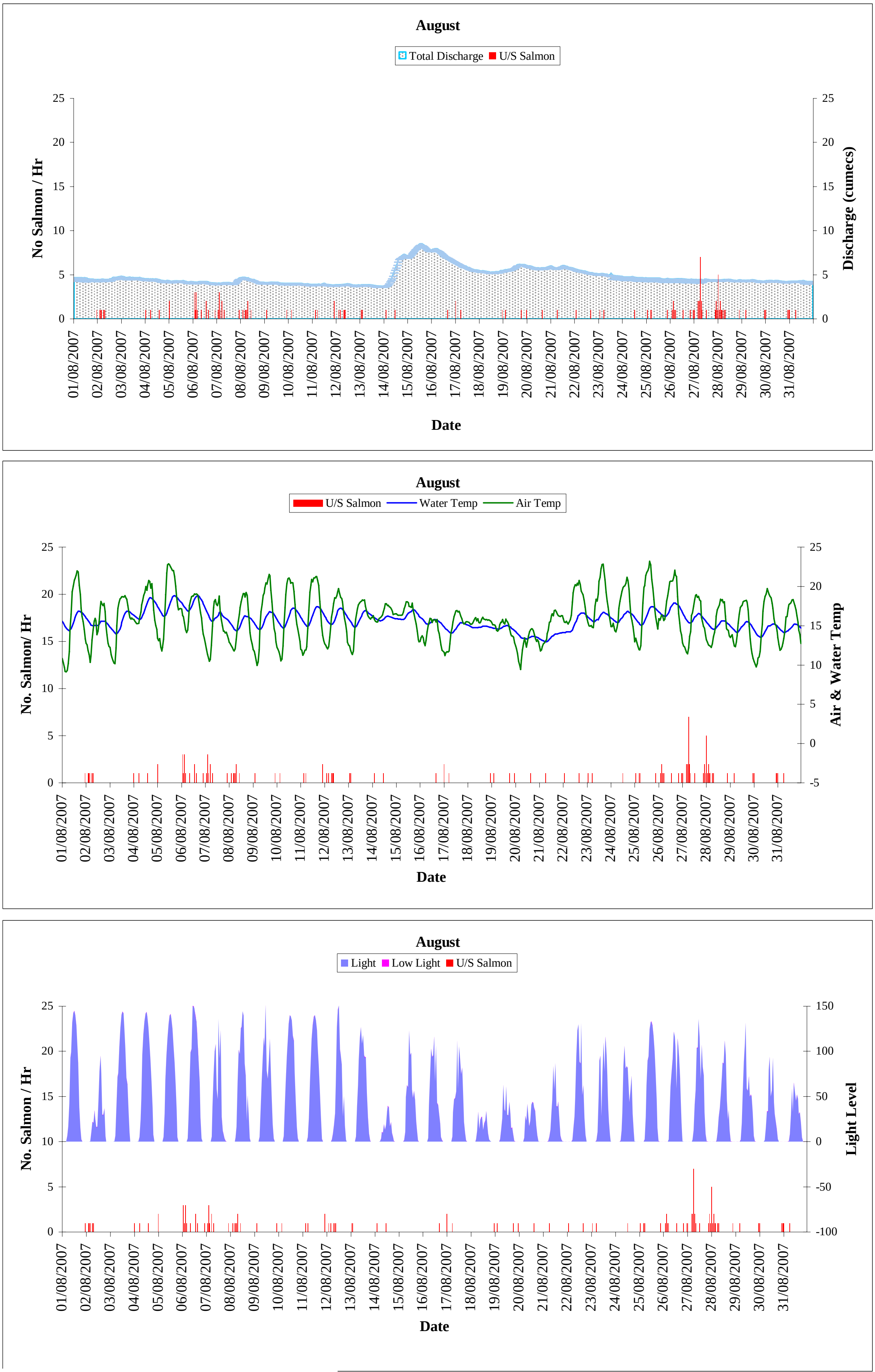
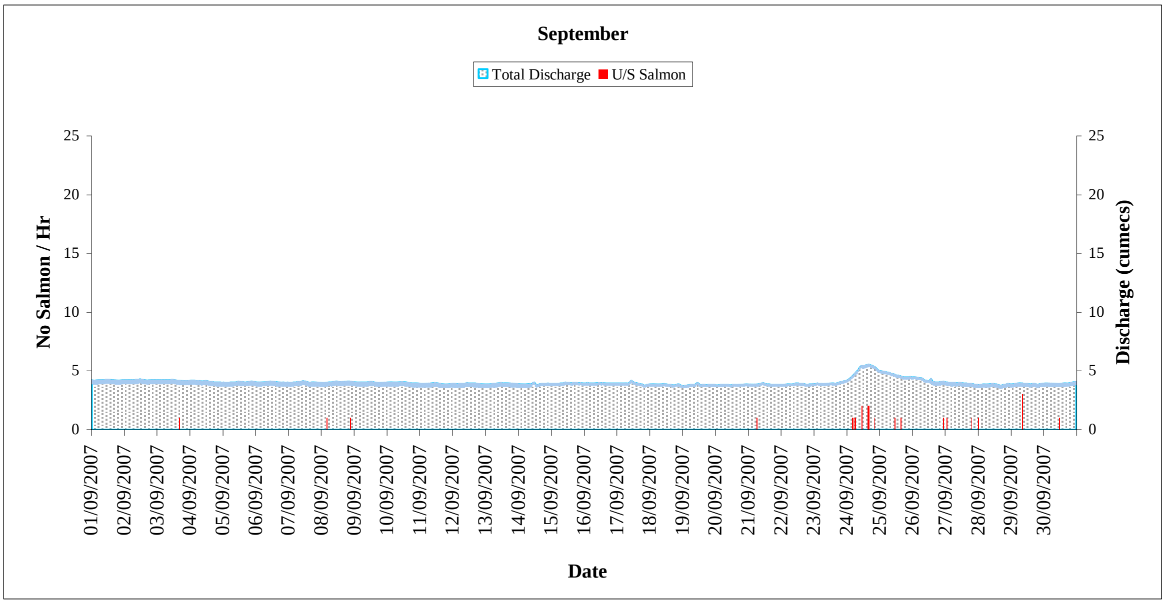
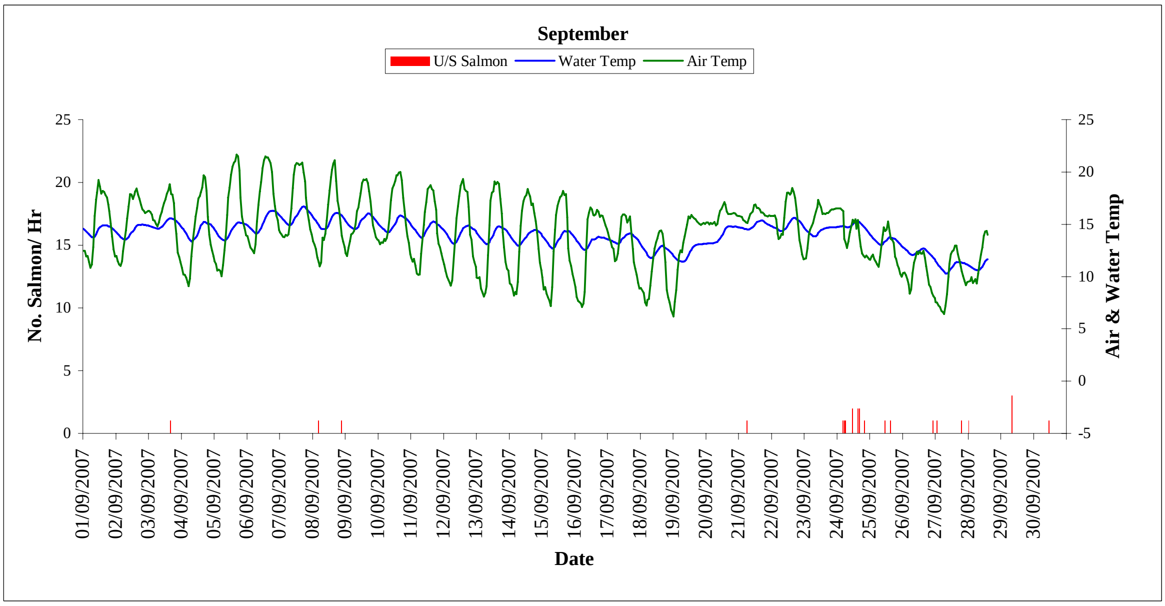


Figure 10: Hourly data





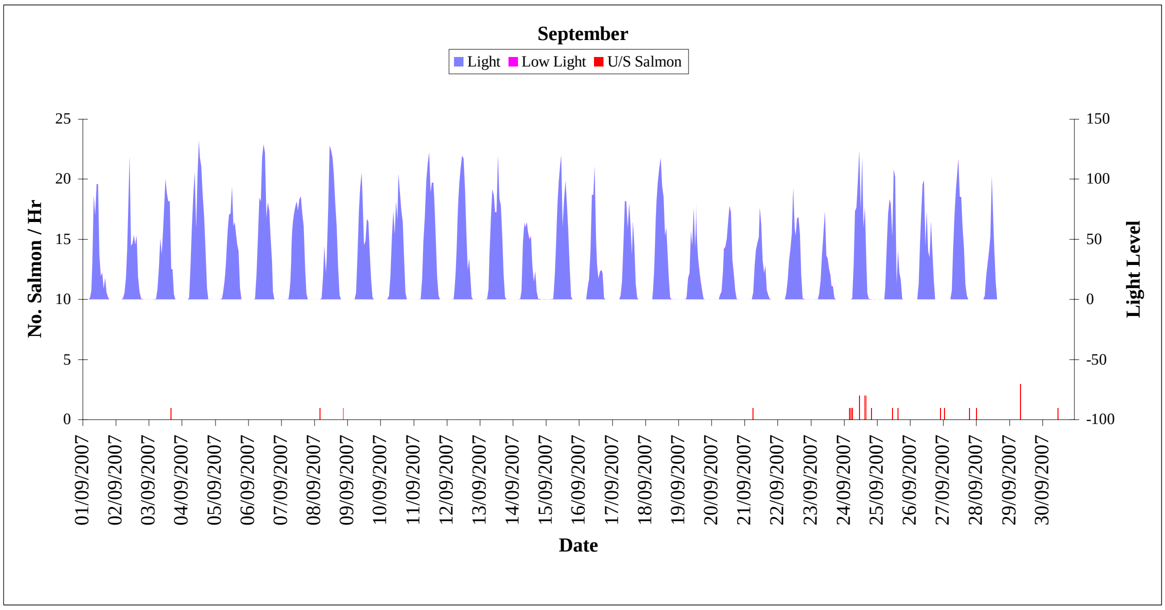
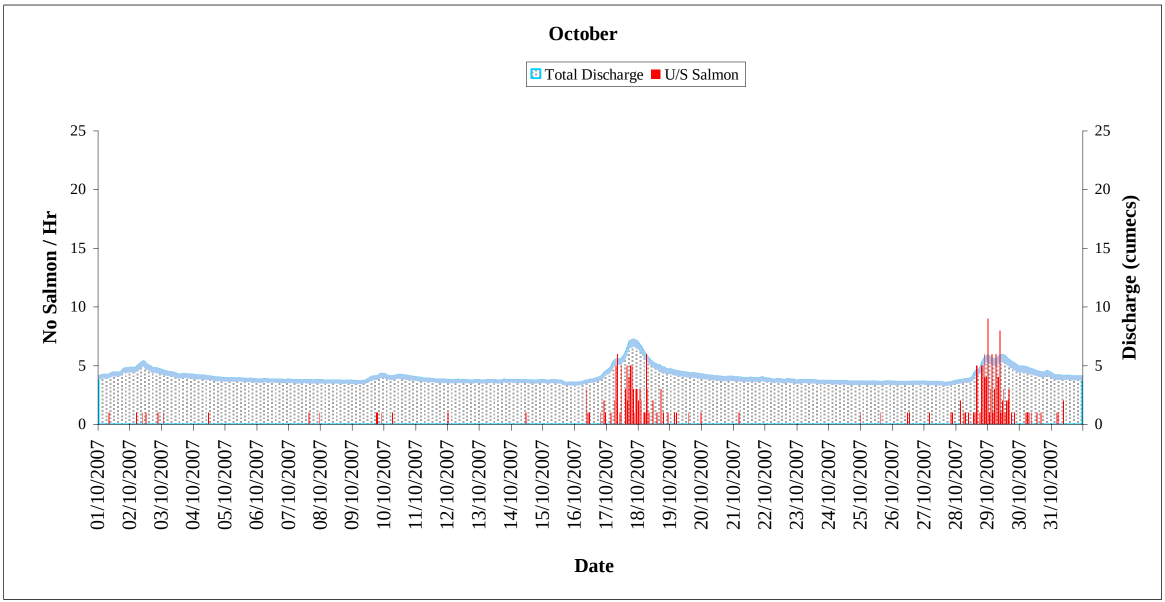
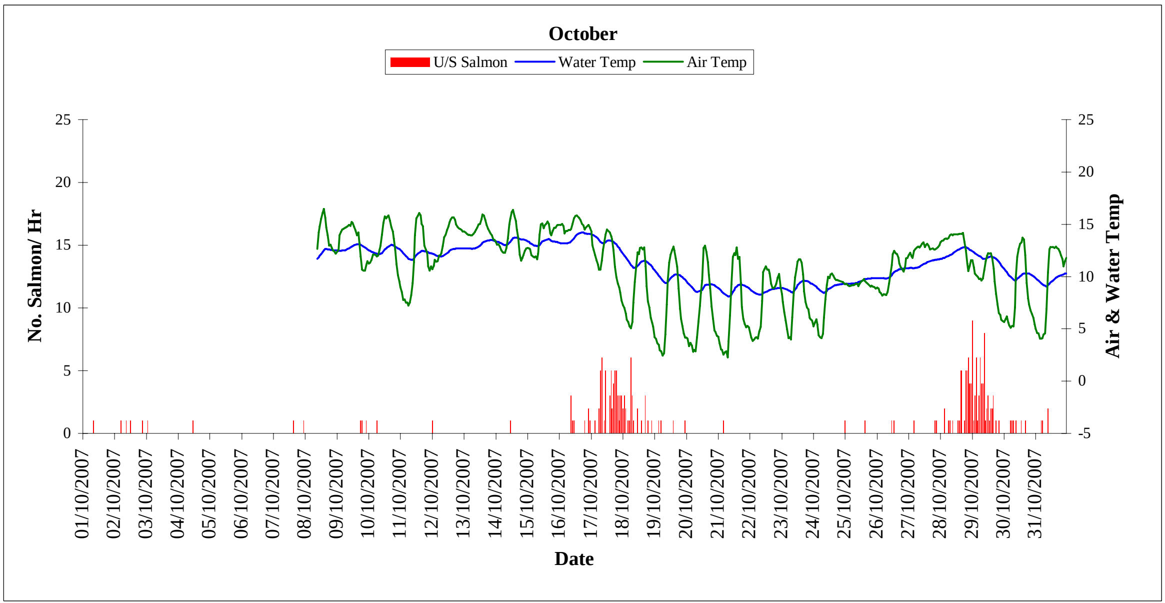


Figure 10: Hourly data





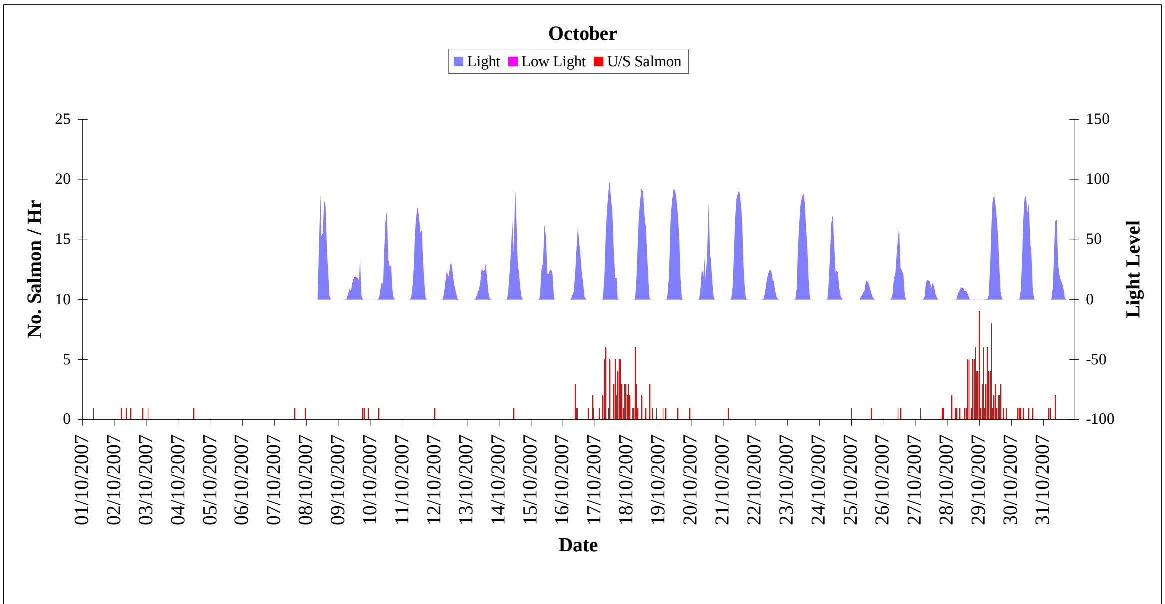
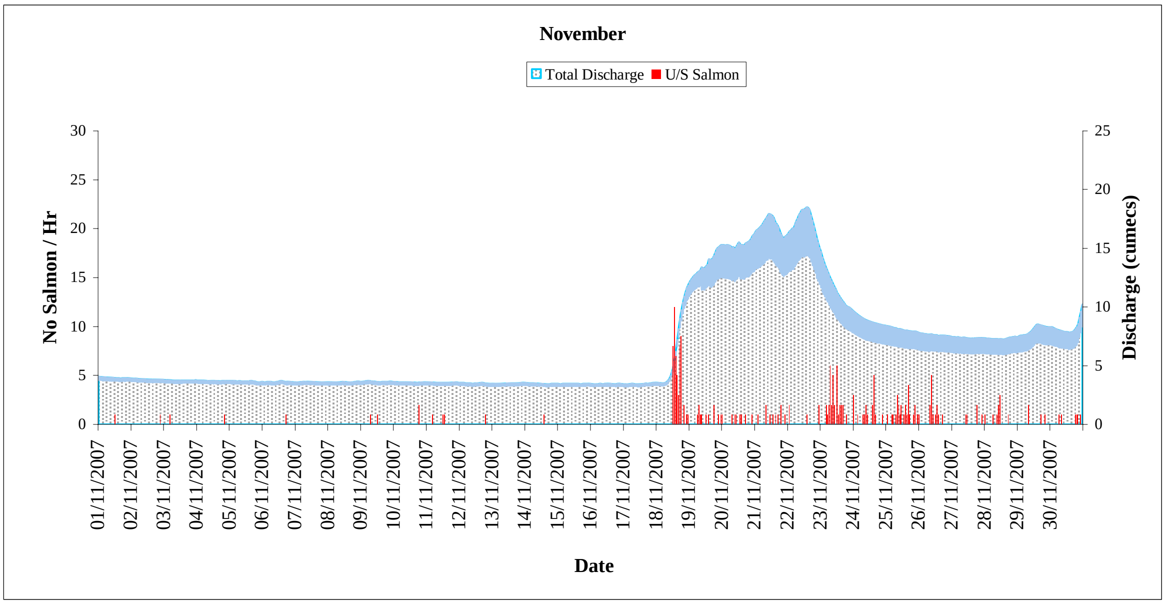
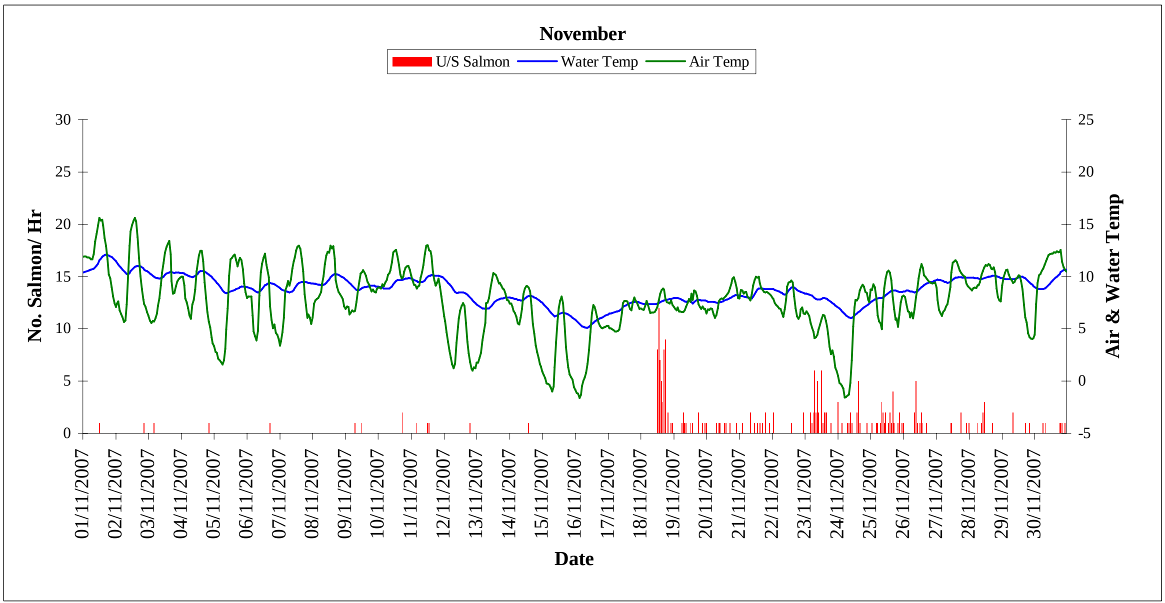


Figure 10: Hourly data





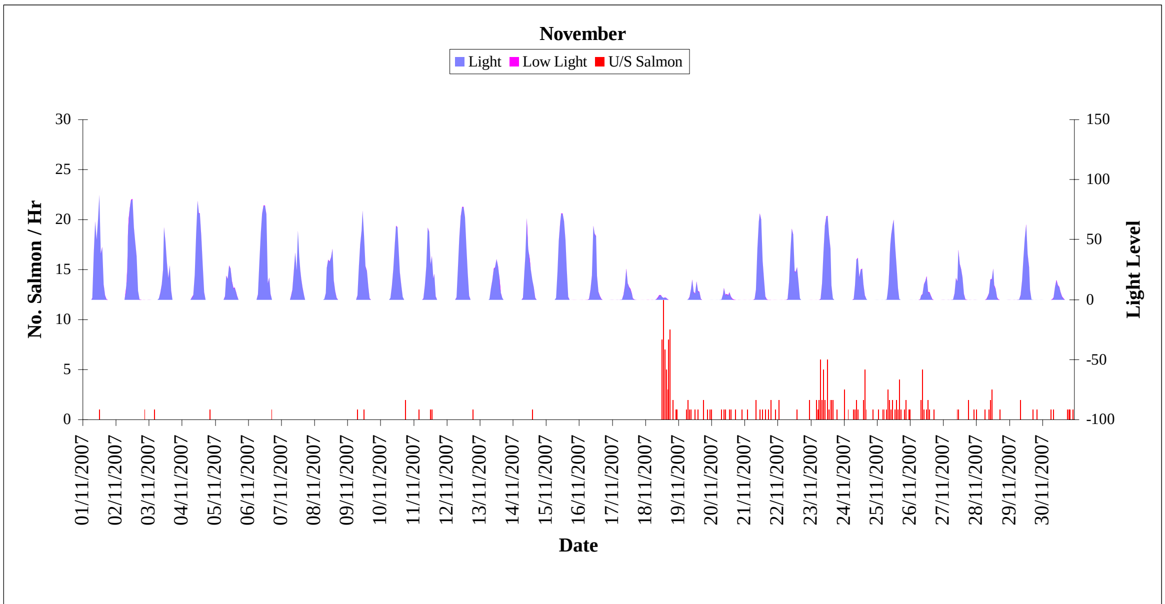
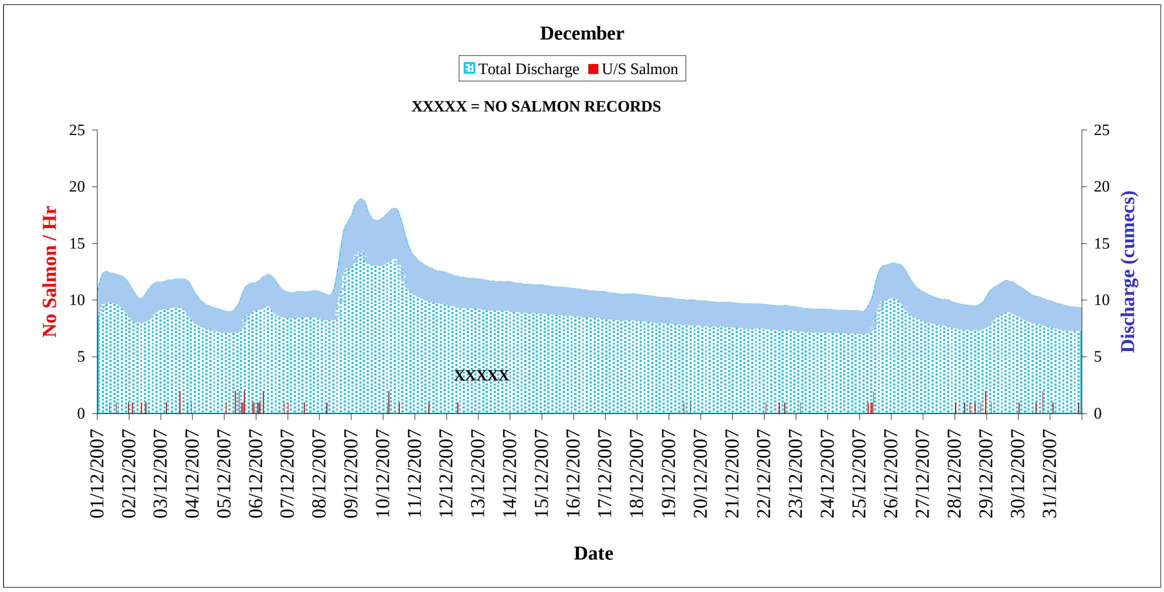
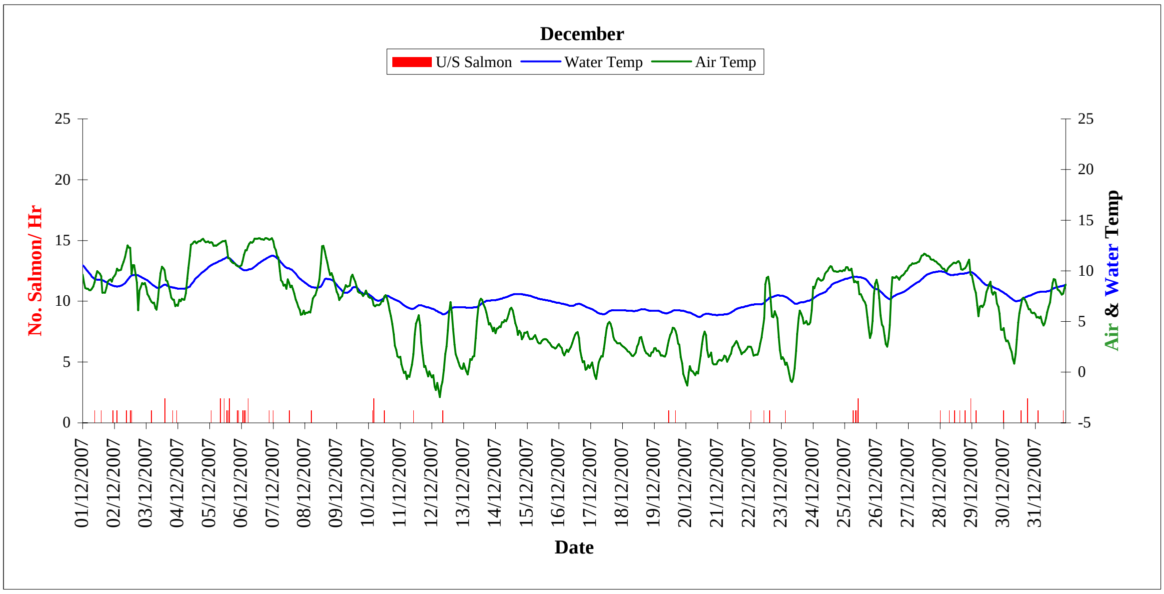


Figure 10: Hourly data





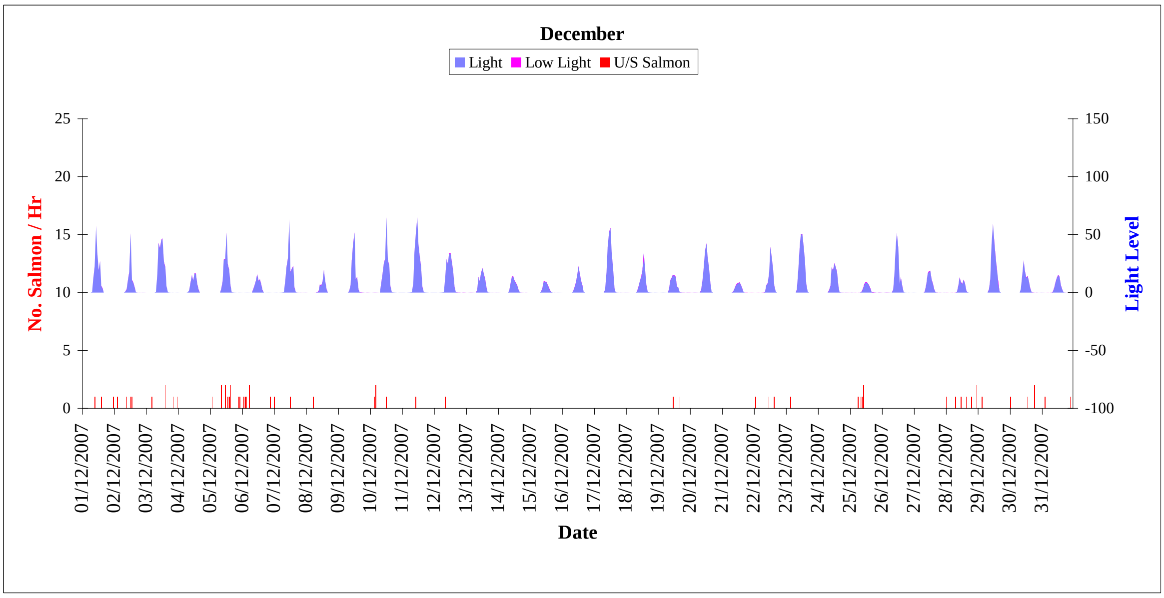
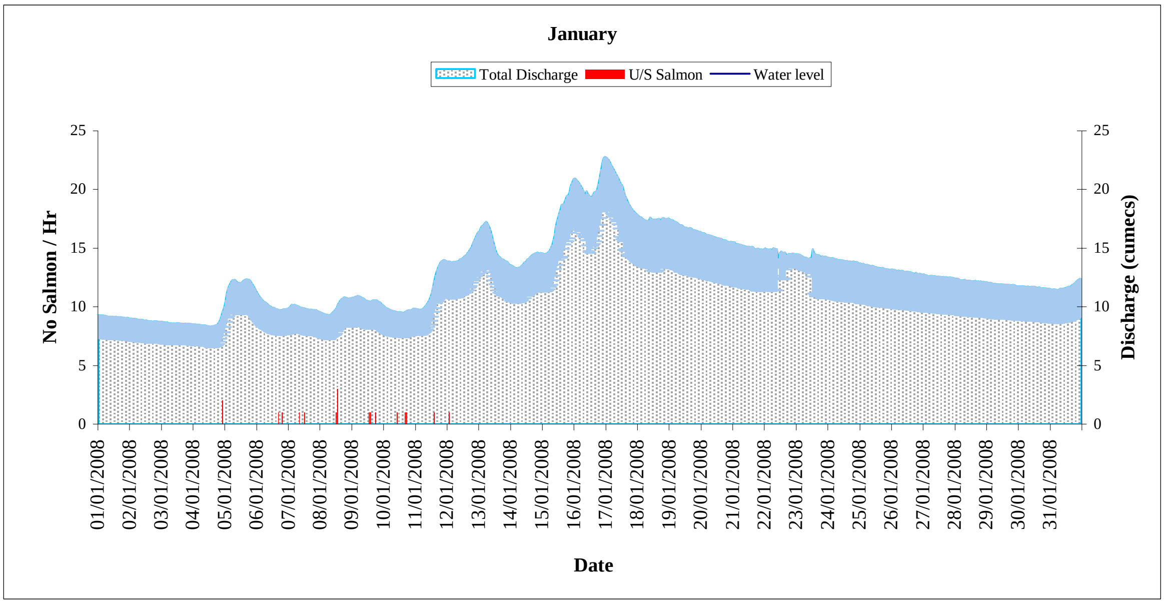
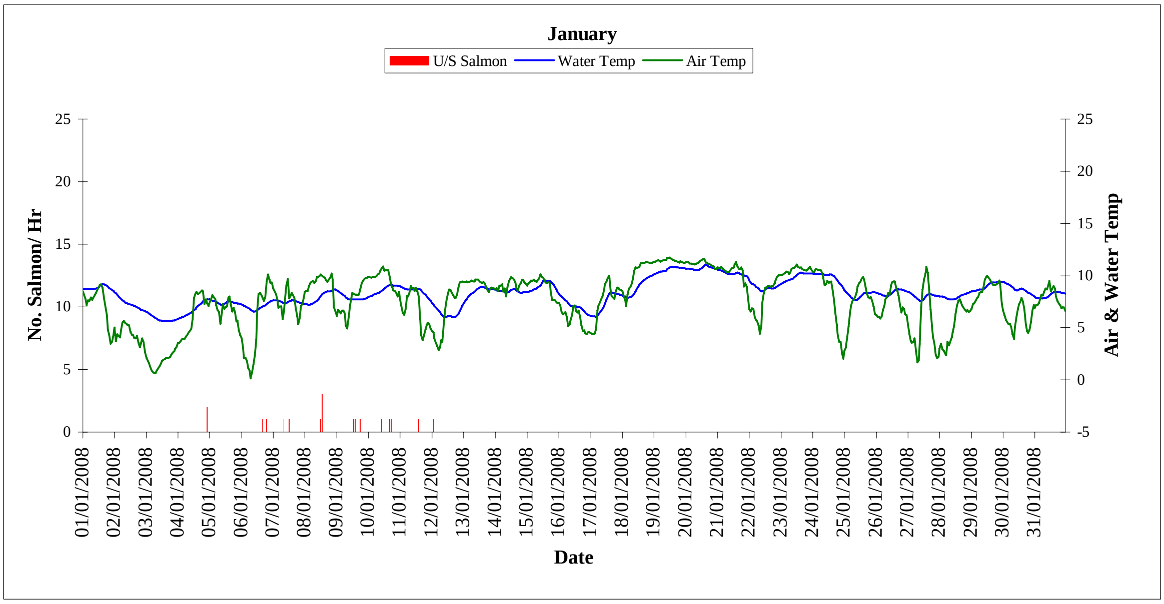


Figure 10: Hourly data





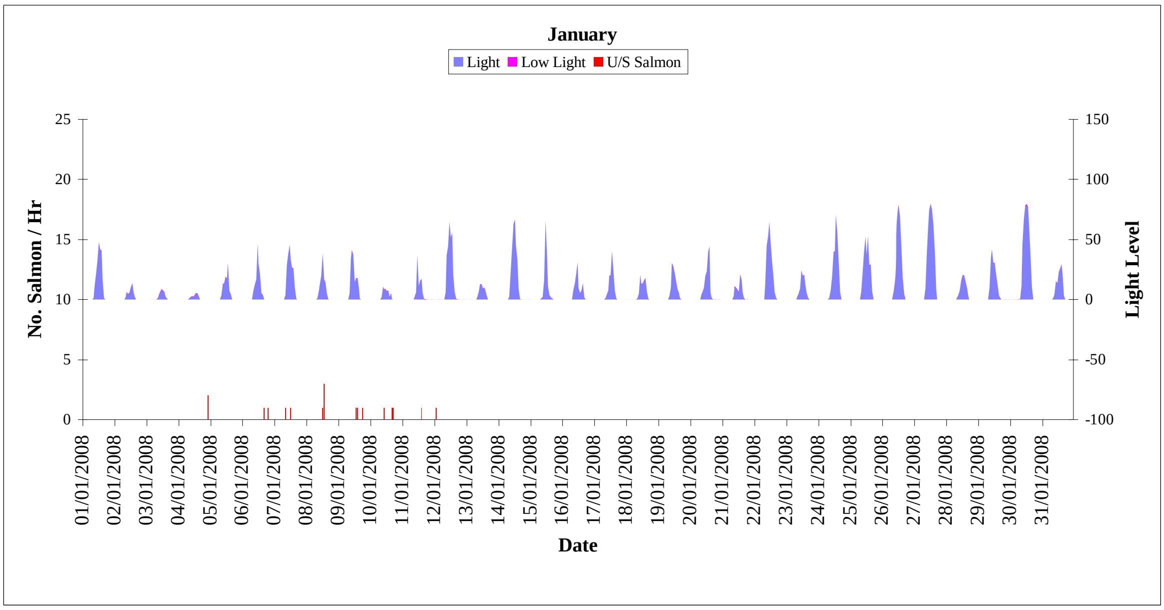


Figure 10: Hourly data

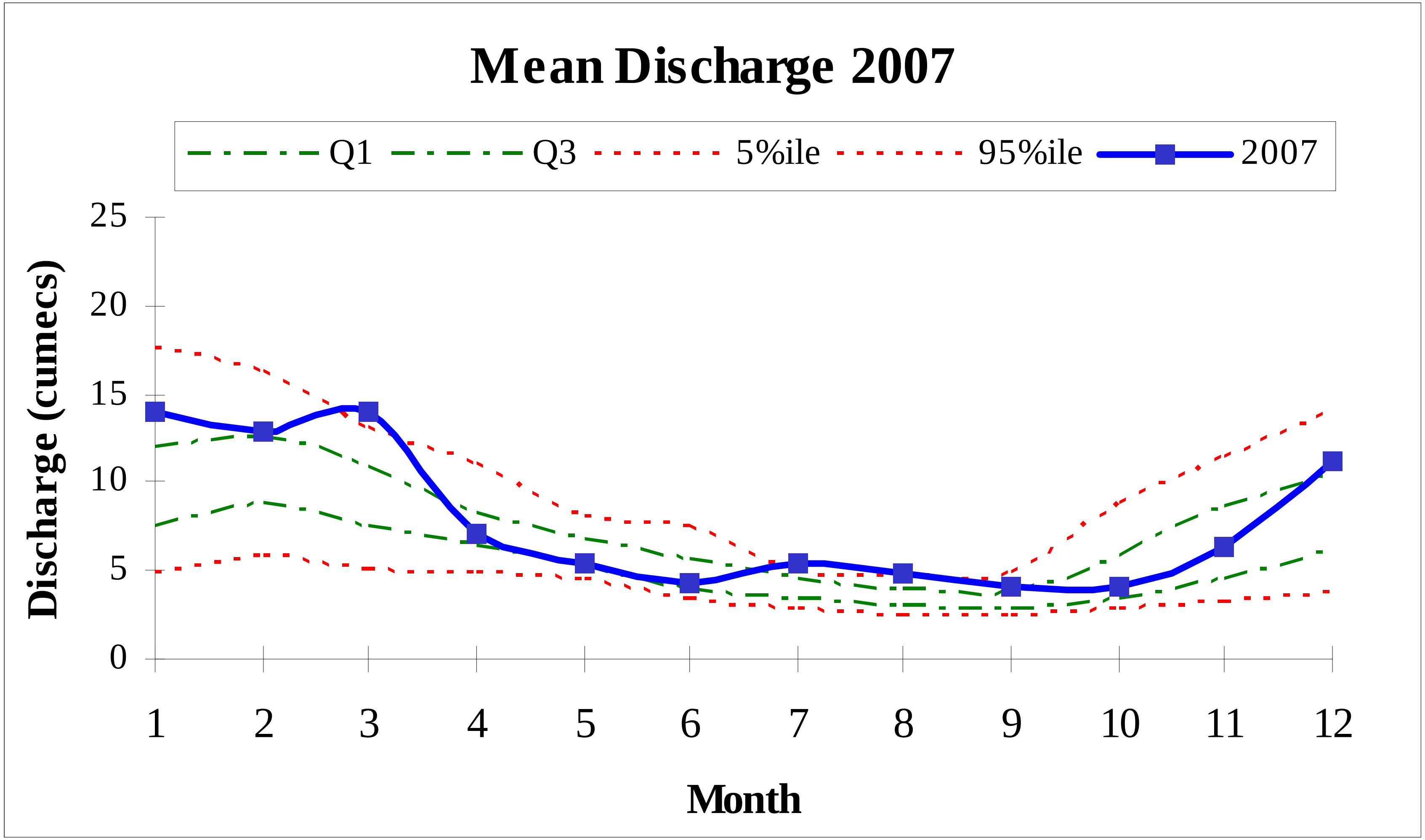


Figure 11: Monthly mean discharge and long-term percentile data (Jan – Dec data)

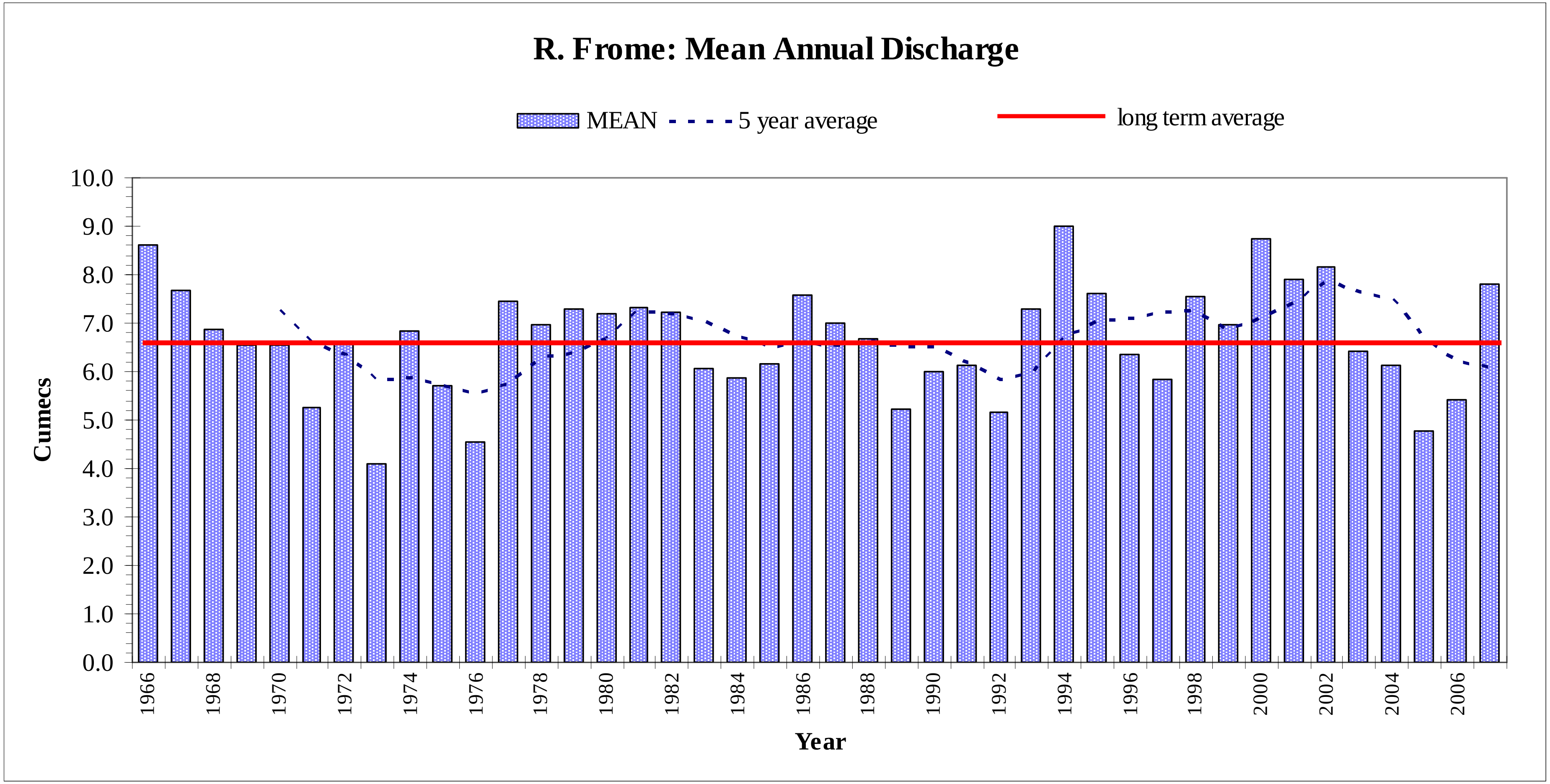


Figure 12: River Frome long-term annual discharge

DISTRIBUTION SHEET

To be completed by all Project Leaders producing commissioned research project reports. Please bind a copy of this distribution sheet as the final page in all internal CEH Dorset copies of the report.

1.	Title: The 2007 East Stoke Salmon Counter Records Authors: W R C Beaumont, L Scott, and A T Ibbotson Project No: C02896NEW / C02038NEW Master copy held by: W R C Beaumont **Report access code (assign a suitable code from list below)**: N		
2.	DISTRIBUTION LIST [A-E standard, F other]	No. copies	Date
A.	Contract customer:		
B.	CEH Library, CEH Lancaster, + digital copy	1	Mar 2008
C.	CEH Dorset Library	1	Mar 2008
D.	Project leader: W R C Beaumont	1	Mar 2008
E.	Director CEH/Director Water (**front cover only**)	(2)	Mar 2008
F.	Other (list below and indicate no. copies in RH column)		
1.	Environment Agency, Wessex Region, Exeter	1	Mar 2008
2.	Environment Agency, Wessex Region, Blandford	1	Mar 2008
3.	Environment Agency National Salmon Centre (R Evans)	1	Mar 2008
4.	Wessex Salmon & Rivers Association	1	Mar 2008
5.	The Frome & Piddle Fishing Association	1	Mar 2008
6.	Frome Conservation Trust	1	Mar 2008
7.	General Distribution	5	Mar 2008
8.			Mar 2008
	Total number of copies made	11	

REPORT ACCESS CODES

S **In strict confidence - restricted access -** Access to named customer(s) - (could be named restricted access individuals), CEH Directorate, Project Leader and all authors.

C **In confidence - restricted access -** Access to customer, CEH Directorate, Project Leader, all authors, and CEH staff with permission of Project Leader.

N **Normal access -** Access to customer and all CEH staff. Access to visitors and general public with permission of Project Leader.

G **General access -** General access to anyone as required.